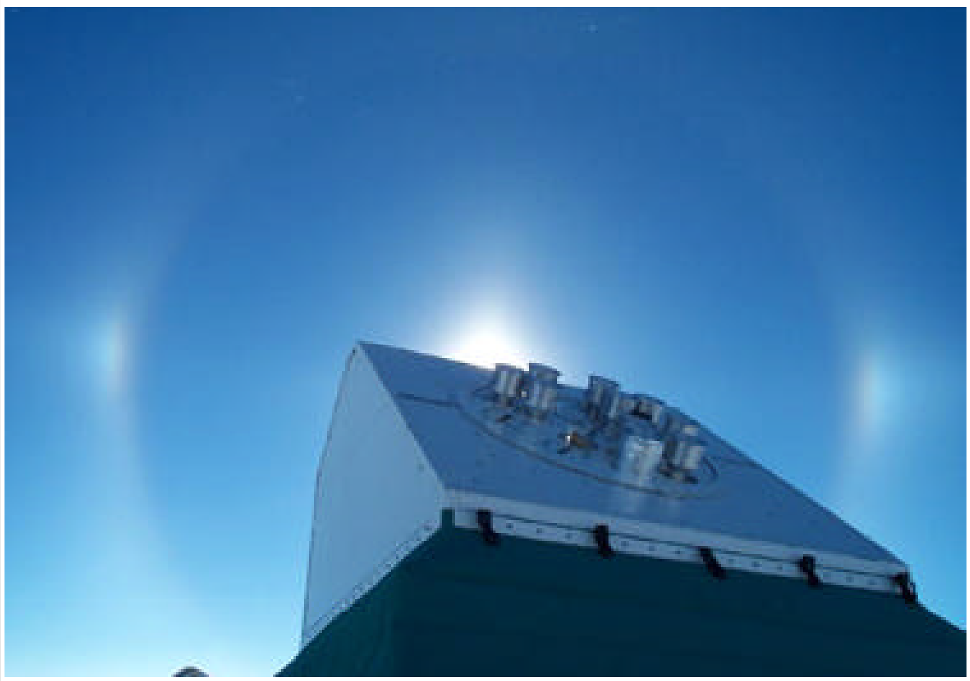
The Integrator

Volume 10, No. 3 | Published by the Mission Services Program Office | November 2001

Features

Code 450 Mission Services Program

MSP Enables Science at the South Pole



The Degree Angular Scale Interferometer (DASI) is one of many instruments that take advantage of the unique conditions at the South Pole. Funded by the National Science Foundation, DASI investigates the origin of the universe by detecting Cosmic Microwave Background (CMB) Radiation. The Mission Services Program (MSP) provides support to DASI and numerous other science missions at this remote location.

Read more about the MSP's support to "Earth-bound" missions on page 5.

CODE 450
Mission Services Program

A Message from the Associate Director / Program Manager for Mission Services

Autumn is often thought of as a season of change. Correspondingly, the Mission Services Program (MSP) currently finds itself on the brink of a series of transitions.

The Space Operation Management Office (SOMO) is being restructured, which has implications for the MSP and its customers. This restructuring effort, and the subsequent reorganization of the Space Communications Program, will transfer funding responsibility to the Enterprises, and will create a beneficial environment that facilitates interaction between the MSP, the Enterprises, and the customers. Our challenge will be to integrate a cohesive and effective Space Communications Program, where multiple Enterprises share responsibility for program management and funding. MSP managers are currently examining the structure of the Code 450 organization, to determine how we should best adapt to these changes in our environment.

NASA's Consolidated Space Operations Contract (CSOC) contractor has made significant progress towards a major reorganization effort that will decentralize the management of CSOC operations. This change is designed to transfer responsibility for service providing factories to the individual NASA centers. The benefits of this endeavor are already apparent; CSOC staff at Goddard are empowered to be more responsive to our customers, and thus to provide more efficient service.

The Ground Network Commercialization effort achieved a major milestone on October 16, 2001, with the transition of NASA's Svalbard Ground Station to a commercial provider. Congratulations, and thanks to the Government and industry team which made this successful. The MSP and contractor team must continue to work together efficiently to ensure that customer support continues without disruption in this new way of doing business.

We are also in the midst of making preparations to support several important missions—one of which is our own TDRS-I spacecraft. The October launch for TDRS-I has been postponed, allowing additional time to implement a minor modification to the spacecraft to reduce the risk during antenna deployment, and resolve some last minute issues raised in the launch preparation process. The award-winning TDRS Project team is working hard to ensure a successful launch and subsequent mission. Make sure you give them your full support!

Additionally, MSP team members continue to prepare for the upcoming Earth Observing System (EOS) Aqua, Aura, and ICESat missions. Engineers are making modifications to the Ground Network systems that will support these missions. Mission readiness testing for the end-to-end system has significantly progressed over the summer and fall, including successful testing with mission control and data processing elements at GSFC.

Lastly, I would like to commend MSP personnel and our contractor team for the many outreach events they have supported thus far this year. We all need to continue to take advantage of these opportunities to share our knowledge and interact with the public in both the educational arena and the community at large. Thanks for the extra effort!

Phil Liebrecht

Phone: 301-286-5220
Fax: 301-286-1724
Email: Philip.Liebrecht@gsfc.nasa.gov

In This Issue ...

CODE 450

Mission Services Program

So SOMO's Being Restructured…What's Next?

By now everyone has probably heard the news that NASA's Space Communications Program is being restructured. The questions on everybody's mind, including my own, are:

- What's next?
- When?
- What does it mean to the Mission Services Program?

Continuing shortfalls in the space communications budget are requiring the Science Enterprises to assume more and more of the funding responsibilities for space operations services. The Science Enterprises (SOMO's customers) want more control, given their role in funding the space operations activities.

In late August, Bob Spearing, the Deputy Associate Administrator (Space Communications), led a meeting in Houston to map out the Agency's strategy for management of future Space Operations services. Representatives from the affected Enterprises and Field Centers attended, as did select SOMO personnel. Phil Liebrecht (Code 450) and John Campbell (Code 400) represented the GSFC.

The outcome of the meeting was a firm decision to reorganize the NASA space operations management structure, and to allow the Enterprises to take more control and responsibility for space operations, under the leadership of Mr. Spearing. It was determined that the Enterprises would name "Program Executives" to manage their respective pieces of the infrastructure.

The Space Flight Enterprise (Code M) will maintain responsibility for the Space Network, TDRS H, I, J Project, The NISN, the Launch Control Center (LCC) at KSC and the Mission Control Center at JSC. The Space Science Enterprise (Code S) will manage the Deep Space Mission System, which includes the Deep Space Network. The Earth Science Enterprise (Code Y) will oversee the Ground Network, while the Aerospace Technology Enterprise (Code R) will manage the Western Aeronautical Test Range.

NASA HQ will also retain an integration role, although it will function at a much higher level than SOMO did, with more responsibility delegated to the Centers. CSOC contract administration activities will remain at JSC; however, the SOMO will be reorganized, and will focus on support of NASA Headquarters and the Field Centers, and the management of the CSOC contract. This proposed organization is depicted in Figure 1 at right.

The exact timing and means of this transformation are still being determined. Extensive coordination with NASA HQ is taking place, and issues resulting from the FY02 budget process must be addressed. Some SOMO personnel have already departed for other opportunities—Ed Burns has taken a six-month detail to work the SOMO-to-HQ transition for Mr. Spearing, and Jon M. Smith has moved to other commercialization initiatives at JSC. SOMO still exists and is still scheduling SOCBs, Pre SOCBs, etc., to ensure a smooth transition of responsibility to HQ and other Field centers.

The Mission Services Program (MSP) management team is discussing options internally, as well as with Code 400 and NASA HQ regarding how the organization can best respond to the proposed changes in reporting, accountability and funding flow. Maintaining effective leadership of the multi-mission service factories

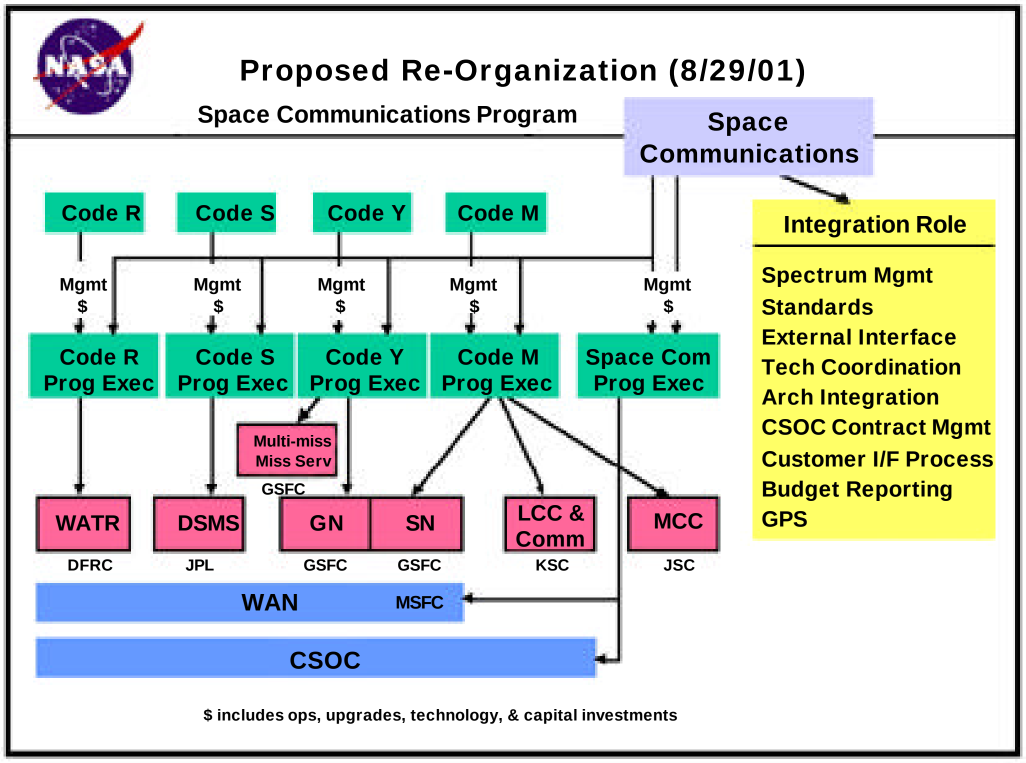


Figure 1. Proposed Organization of SOMO

(the Space Network, Ground Network, etc.) and TDRS H, I, J together under Code 450 management is the top priority. The essential question is, how can Code 450 facilitate effective support of our customers and successful interaction with the HQ Program Executives? Reorganization of the MSP is an option under consideration; however, limiting the impact of any possible reorganization on our personnel is a major consideration. Phil Liebrecht and the MSP management team will provide information on any proposed changes in the near future, as the agency formulates the details of the new Space Communications and Data Systems Program.

By Kevin Mc Carthy/GSFC Code 450

For additional information on this topic, please contact the author via email (Kevin.P.McCarthy.1@gsfc.nasa.gov) or telephone (301-286-9516).

MSP Enables Science at the South Pole

Oftentimes, when we learn about the successes of Code 450, we hear news concerning high profile customers, such as the Shuttle, International Space Station, and Hubble Space Telescope. Yet MSP personnel and resources are dedicated to the support of numerous other missions, many of which are not even in orbit around the earth!

For example, MSP resources are actively facilitating science activities at the South Pole, one of the three year-round research stations operated in Antarctica by the National Science Foundation. TDRS F1, the first satellite launched in the TDRS series, is still very much “alive.” Strategically placed in an orbit enabling it to be “visible” from the South Pole region for approximately 5.5 hours per day, TDRS F1 and the Space Network (SN) systems supporting it play an integral role in several important science programs.

Through TDRS F1, Code 450’s SN provides researchers at the South Pole two data links: a K-band Single Access Return link (KSAR) and an S-band Single Access Forward and Return (SSAF/R) link.

The KSAR link is used primarily for the transfer of large volumes of science data from experiments at the South Pole to the U.S. for distribution to researchers. The biggest KSAR customer by far is the research project known as AMANDA (Antarctic Muon and Neutrino Detector Array), run by a consortium of universities and research organizations headed by the University of Wisconsin/ Madison.

AMANDA’s mission is to observe high energy neutrinos that originate from points in outer space. Interestingly enough, AMANDA makes its observations from deep in the Antarctic ice, pointing downward to observe particles that pass through the Earth. AMANDA is the world’s largest particle detector, and consists of over 500 widely spaced basketball-sized photomultiplier tubes (PMTs) that are “strung” on cables buried between 1,400 and 2,400

(continued on page 6)

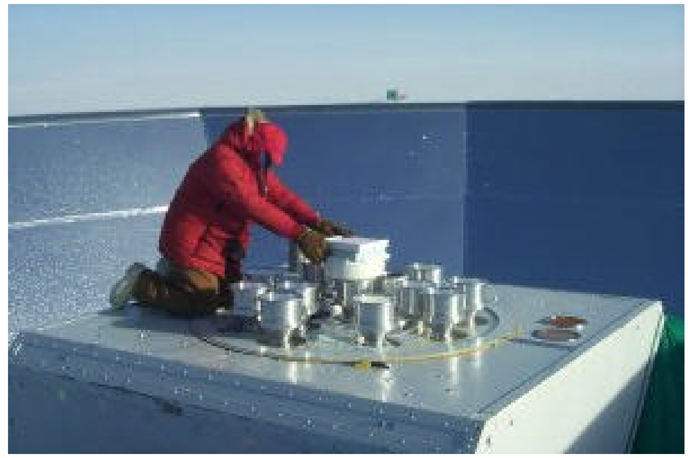
(continued from page 5)

meters beneath the ice surface. High energy neutrinos traveling from outer space through the earth will occasionally interact with ice or rock and create a muon, which emits Cherenkov light. The muons can be tracked by measuring the arrival times of the Cherenkov photons at the PMTs. From this data, astronomers hope to discover more about black holes, stellar explosions, and other potential neutrino sources. AMANDA utilizes the KSAR link to send from 2 to 5 Gigabytes of data per day—the largest daily data transfer by satellite in the history of the US Antarctic Program.

Photo of AMANDA showing the PMTs “strung” on cables buried deep beneath the ice surface

Several other astronomy research projects also transmit data via the KSAR link. One of the major customers is the Degree Angular Scale Interferometer (DASI), which measures slight temperature variations in the Cosmic Microwave Background Radiation (i.e., the “Big Bang” signature). DASI is able to detect temperature differences that existed when the universe was a mere 400,000 years old (it is over 14 billion years old now). Last spring, scientists utilized data from DASI to confirm a theory called cosmic inflation. This theory proposes that the universe underwent a gigantic growth spurt in a fraction of a second just moments after the big bang.

In addition, there are also numerous other science projects going on as part of the Foundation’s United States Antarctic Program, which involves university-based researchers and other Federal agencies including NASA. Over 3,000 scientists and support personnel will be conducting experiments in astronomy, biology, oceanography, meteorology, and other earth sciences over the



Making adjustments to the DASI, located at the National Science Foundation's station at the South Pole.

course of the research season, which lasts from October to February. Nearly all of these projects utilize the SN data links in some manner.

The SSAF/R link provides the best Internet link into the Foundation’s South Pole Station. In fact, when TDRS F1 is visible at the Pole, South Pole Station has the best Internet link of any Antarctic station. The SSAF/R link provides a 1 Mb/s link (very close to a standard 1.5 Mb/s “T1” link). This high quality link is used for many purposes at the Pole: station operations, science research support, science data transfer for smaller science projects, remote instrument control from the states, voice-over-Internet telephone service, video conferencing, and telemedical applications.

Perhaps the most universal application supported by the SSAF/R link is email. The capability to access email positively impacts the morale of everyone spending time at the South Pole. South Pole Station is the NSF’s most isolated and environmentally extreme research station, and this contact with the outside world is invaluable.

Thus, the SN links are vital to the South Pole Station, and their loss would represent a major impact to the conduct of science, operations, and station morale.

Information from Patrick Smith/NSF

For additional information on NSF research projects conducted at the South Pole and elsewhere in Antarctica, please see http://www.nsf.gov or contact Peter West/NSF Public Affairs Officer via email (pwest@nsf.gov).

Code 450 Reaching Out

In an effort to energize and stimulate the communities in which we live, Mission Services Program team members find varied ways to share their NASA experience. In the last several months, many good things have been happening.

Some important meeting and greeting has been going on. Larry Phillips of the Customer Commitment Office has been very involved in supporting programs for minority students who have an interest in space. He spoke to the Mayor's Basketball Academy in Baltimore, supports the ongoing GSFC Minority University Program, and participates in minority program activities at the GSFC Visitors Center.

Emeritus employees Bob Stanley and Hugh O'Donnell planned and provided educational experiences, along with mentoring, to two summer students from the National Space Club Scholars Program. An Ontario, Canada school teacher sent a letter of thanks to Bob for Amateur Radio Club support of the Shuttle Retransmission Program. Stanley also represents the Program on the JSC Outreach and Education Coordination Committee, working with other Centers, including JPL.

Several of the Mission Services team members have given presentations to varied audiences. Program Manager Phil Liebrecht spent an evening with engineering students at Prince George's Community College, speaking and taking questions. Dennis Vander Tuig, Program Business Manager, participated in a Career Day at Silver Spring International Middle School. Tom Gitlin/Code 453 visited the fifth grade class at Mt. Harmony Elementary School in Owings, MD on October 8 to talk about satellites. The students asked Tom lots of good questions, and they really seemed to enjoy the discussion! A CSOC employee presented the PAO presentation, "Space Science, NASA and its support organizations," at Pasadena Elementary School.

Two members of the Customer Commitment Office were quite involved with their communities this spring. Jon Walker, Deputy Program Manager for Customer Commitment, represented NASA at a videoconference with the Discovery Center of Science and Technology for Pennsylvania High Schools students. Not to be outdone, Steve Kremer, Mission Commitment Manager for Code Y, first spoke to physics and math students at Southern Garrett Senior High School, then participated the following day in a Career Expo at Garrett Community College, McHenry, MD. By May, he had participated in the Snow Hill Elementary School reading festival demonstrating to children why reading is important.

Science Fairs are another favorite way to get involved in the community. Keiji Tasaki, Operations Services Project Manager, received a laudatory letter for judging the St. Joseph's Science Fair in Beltsville, MD. Bly Barbehenn and Reginald Hunt, who support the Customer Commitment Office, were judges for the Hyattsville Middle School's Science Department science fair. Finally, Jon Walker was Head Judge for an Odyssey of the Mind problem at the Northern Virginia regional meet at Hayfield Secondary School.

We applaud these committed members of the Program team for their generosity in sharing their time and Mission Services spirit.

By Rosemary Bruner/Code 450

For more information regarding this topic, please contact the author via telephone (301-286-2648) or email (Rosemary.V.Bruner.1@gsfc.nasa.gov).

With an Eye to Safety

In an effort to stimulate safety awareness in the workplace and at home, Code 450 has sponsored monthly safety briefings spanning wide-ranging areas of interest.

In the spring, the Program Office brought Rob Beyma, from the Wallops Flight Facility, to give a talk on Range Safety. Another topic that drew high attendance was Identity Theft, with many helpful hints on protecting personal information. Curtis Emerson, Operations Services Project, delivered May's briefing on the topic of IT Safety and Security, a major concern throughout the Program.

As summer approached, the Program Office provided information on heat stress and related illness, West Nile Virus and Lyme Disease. The Operations Services Project asked CSOC to present July's safety topic, Flight Mission Safety. The Program Office closed out the quarter with Pet Safety, Fire Safety, and Travel Security, while the TDRS Project offered Hot Conditions/Be Cool and Preparing for Disaster. Finally, the Operations Services Project provided a CSOC speaker in October to talk about the Leonid Meteor Showers that are an annual occurrence in November.

Watch for additional briefings on a variety of topics in the coming months.

By Rosemary Bruner/Code 450

For more information regarding this topic, please contact the author via telephone (301-286-2648) or email (Rosemary.V.Bruner.1 @gsfc.nasa.gov).

Updated MSP Schedule in This Issue

Please check out the Mission Services Projects Schedule chart located in the center of this issue. We have updated it to reflect current project schedules and events. Further updates will be provided in future issues of *The Integrator.*

CODE 451

Customer Commitment Office

Space Network Online Information Center

We've changed our name!

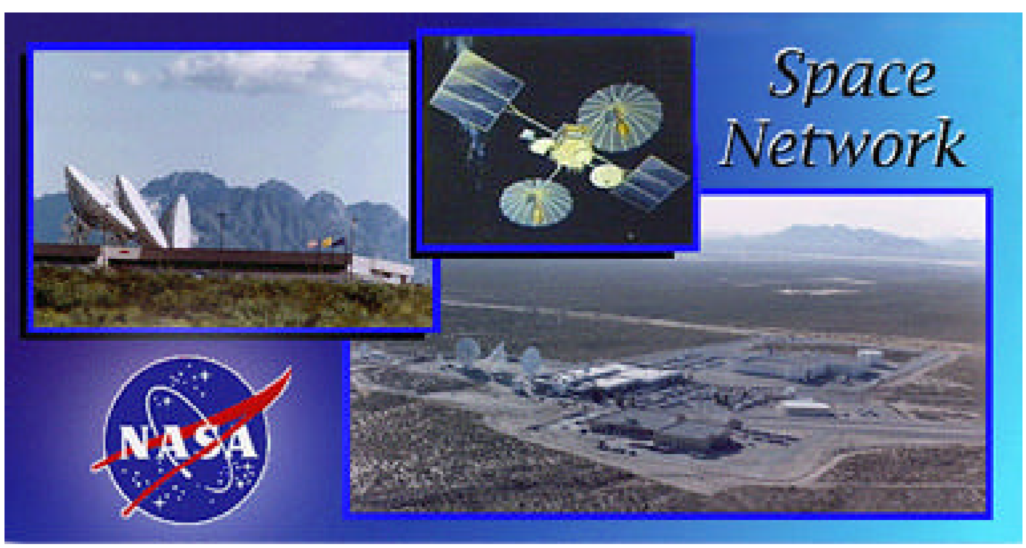
The site formerly known as the TDRSS Online Information Center is now the Space Network Online Information Center. The new title more accurately reflects the scope of information that the site provides.

The Information Center has evolved over the past few years to include a wealth of information beyond the Tracking and Data Relay Satellite System (TDRSS). You will still find authoritative information on TDRSS, but you can also access information and links about other Mission Services Program and Space Network activities, as well.

So, as always, if you have questions about TDRSS or the Space Network, check out the Space Network Online Information Center. We are continually updating and improving the site. Recent improvements and additions include links to the Communications Link Analysis System web site that provides refined forward and return service link budget calculators. The calculators are useful to determine if TDRSS is a viable solution for your communications requirements.

Space Network Online continues to support the Ground Network link budget calculators and the Universal Spacecraft Clock Calibration System calculator. We have added an information module containing recent SN overview presentations. The Space Network Online Information Center also provides links to the Space Network User's Guide.

Use our feedback form to email specific questions to us. We will direct your question to the appropriate expert and return an answer to you via email. As always, the calendar listing upcoming launches and other activities of interest is updated monthly. The entire site is updated twice monthly to ensure information is current and accurate.



The Space Network Online Information Center can be accessed at *http://nmsp.gsfc.nasa.gov/tdrss/*

Detailed information is currently available on:

- The Tracking and Data Relay Satellites (including TDRS H, I, J)
- Demand Access
- The White Sands Complex including WDISC
- Guam Remote Ground Terminal
- McMurdo TDRSS Relay Terminal System
- TDRSS Telecommunication Services
- Customer Communication Systems and Products (including Transponders)
- TDRSS Applications
- PORTCOM and TILT
- Plus much more…

By Jeff Glass/FHA

Plucky IMP Completes 28-Year Observing Marathon

The Interplanetary Monitoring Platform (IMP 8) spacecraft is retiring after 28 years on duty being buffeted by the solar wind and zapped by cosmic rays. Launched on October 25, 1973, IMP 8 was built and operated at NASA's Goddard Space Flight Center in Greenbelt, MD, and has provided important space physics data as part of NASA's Sun-Earth Connections research program.

"We will miss IMP 8 because it reliably provided unique data for so long," said Dr. Joseph King, project scientist for IMP at Goddard. "However, due to severe budget constraints at NASA's Office of Space Science, and the failure of the IMP 8 magnetometer during the year 2000, a panel of senior Sun-Earth Connection scientists advised OSS management that continuing IMP operations may inappropriately divert scarce resources from even more science-effective missions."

Over the past 28 years, more than one thousand scientific papers have been published in the refereed scientific literature in which IMP 8 data were the sole data used or were important adjuncts to data from other missions. Refereed papers are endorsed by independent experts chosen by the editor of a scientific journal before they are accepted for publication.

IMP 8 has deepened understanding of the space environment near Earth in many ways. Observations from IMP 8 provided insight into plasma physics, the Earth's magnetic field, the structure of the solar wind, and the nature of cosmic rays.

Electrically charged gas, called plasma, blows outward from the Sun at typical speeds of 250 - 300 miles per second and is known as the solar wind. IMP 8 helped detail the complex structure of the solar wind. Magnetic fields embedded in the solar wind plasma get twisted into a spiral pattern due to the Sun's rotation. Explosive events on the Sun hurl clouds of plasma that plow into slower moving streams in the solar wind, warping magnetic fields carried by both. IMP 8 data, observations from the Pioneer and Voyager spacecraft in the outer reaches of the solar system, and from the Ulysses spacecraft orbiting over the poles of the Sun, helped paint this elaborate picture.

Consistent coverage for such a long time recently enabled IMP 8 to uncover a curious long-term pattern in the solar wind, which in turn led to new insights on the magnetic dynamo churning within the Sun. Although one would expect that, over time, the solar wind should blow at the same average speed from any place on the Sun, IMP 8 discovered that the Sun has a "sweet spot" where it blasts plasma into space faster than anywhere else. The average solar wind speed varies from place to place on the Sun, from as much as 285 miles per second around 70 degrees longitude to as little as 265 miles per second around 135 degrees longitude. The average strength of the magnetic field carried by the solar wind depends on solar location as well.

This pattern served as a clue for researchers analyzing the solar surface and interior with other observatories on the ground and in space. They discovered that helical, twisting motions of plasma flows and magnetic fields deep inside the Sun contribute to the generation of the solar magnetic field.

"This unexpected pattern persisted for at least 28 years despite unceasing change on the Sun, including the complete reversal of the Sun's global magnetic field direction every 11 years, so we knew it must be telling us something important," said King.

IMP 8 also helped scientists understand very high-speed subatomic particles, called galactic cosmic rays, that constantly bombard Earth from space.

"The same fleet of interplanetary spacecraft that worked with IMP 8 to study the solar wind also used IMP 8 as the anchor point near Earth to determine how solar wind variability and the large scale structure of the interplanetary magnetic field affect the motion and number of cosmic rays able to penetrate to the inner solar system," said King.

Closer to home, plasma "clouds" in the solar wind occasionally slam into the region of space occupied by the Earth's magnetic field, called the magnetosphere. Processes associated with the physics of plasma trapped in the magnetosphere cause

(continued on page 10)

(continued from page 9)

geomagnetic storms and substorms. Intense auroral (northern lights) displays, magnetic field fluctuations, and occasional power system disruptions are associated with these storms. IMP 8 observations, in coordination with a fleet of spacecraft from the International Solar Terrestrial Physics (ISTP) program, enhanced understanding of how the solar wind causes these events.

IMP 8's longevity presented operational challenges for Goddard.

"It has been satisfying to exploit new technologies to expedite, and make less costly, IMP data flow. However, IMP has had no choice but to continue to use the now largely obsolete VHF telemetry frequencies. (IMP is not Shuttle-accessible, as is the Hubble Space Telescope, whereby onboard technologies can be swapped out by new ones.) The communication network that originally captured IMP 8 data, known as the Spaceflight Tracking and Data Network (STDN), was largely disestablished many years ago. One of the key challenges to the IMP Project over the past 15 years has been to define and evolve an ad hoc IMP 8 VHF telemetry capture network," said King

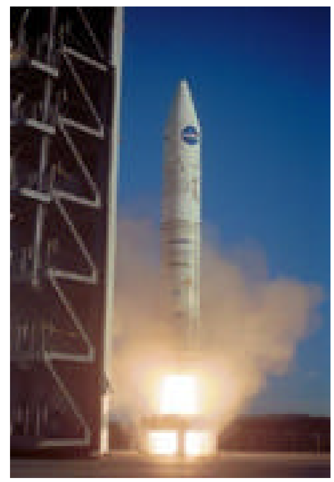
The person-sized IMP 8 is in a nearly circular orbit about the Earth, at a distance a little more than half way to the moon. In this orbit, IMP is in the solar wind about 7 days per orbit and is within the Earth's magnetosphere/magneto-sheath system about 5 days per orbit. Currently, six of the original 12 instruments on board IMP 8 are operational.

IMP 8 was the last of the series of IMP spacecraft which included eight IMPs intended for (and achieving) geocentric orbit and two "anchored IMPs" intended for lunar orbit. These ten spacecraft were launched by NASA in the ten-year period 1963-1973. The IMP spacecraft series was a subset of the highly successful and productive Explorer spacecraft series. IMP 1 was Explorer 18 and IMP 8 was Explorer 50.

From a NASA Press release by Bill Steigerwald/GSFC PAO

For more information on IMP, please contact Dr. Joseph King via telephone (301-286-7355) or email (King@nssdca.gsfc.nasa.gov).

Wallops Supports Kodiak's First Orbital Mission



Artist's rendition of the Athena 1 Lift-off

On September 29, 2001, a new commercial launch facility, the Kodiak Launch Complex located on Narrow Cape in Kodiak Island, Alaska, successfully launched its inaugural orbital mission. One NASA satellite and three Department of Defense satellites, collectively named the Kodiak Star Mission, were placed in nominal orbits by a Lockheed Martin Athena 1 launch vehicle.

After several weeks of launch delays, the Athena 1 rocket burst into the beautiful Alaska skyline at 0240 GMT (10:40 PM EDT) Saturday evening. After flying a near perfect trajectory, the PICOSat satellite was deployed at T+1:03 hours, followed by Sapphire at T+1:09 hours, and PCSat at T+1:10 hours. All three of these DOD satellites were deployed in an 800-kilometer orbit and an inclination of 67 degrees. The last payload to be deployed was the NASA Starshine-3 satellite. After a successful retrograde maneuver to lower the orbit by the upper stage of the Athena vehicle, the Starshine-3 satellite was deployed at T+2:08 hours in a 470-kilometer orbit at a 67-degree inclination.

Telemetry and mobile range control systems located on Kodiak Island

To support this launch, NASA Wallops Flight Facility provided the mobile tracking, telemetry, and command assets and 30 civil servant and CSOC personnel to operate the assets and perform range safety functions. Pat Ladner, Executive Director of the Alaska Aerospace Development Corporation that operates the Kodiak Launch Complex, was very proud to have Wallops supporting Kodiak's first orbital launch.

Ladner said, “The Wallops range safety support has a reputation for being second to none.” The Wallops assets and personnel were mobilized on Kodiak Island, as well as in Cordova, an Alaskan mainland site located just north of Kodiak Island. The mobile assets located on Kodiak Island included a tracking radar, the Mobile Range Control System, 10 and 18-foot Telemetry Systems, and a mobile power unit. The Mobile Command System, the 7-Meter Telemetry System, a tracking radar, and a mobile power unit were also located at Cordova. Wallops assets and personnel provided on-site support to the Kodiak Star Campaign for approximately 14 weeks.

Also supporting the launch were three NASA tracking stations and one European Space Agency (ESA) tracking station. The NASA stations were located in Antarctica, Norway, and Alaska. The ESA station was located in Malindi, Kenya.

The NASA-sponsored Starshine-3 satellite is a student-built satellite developed by the Rocky Mountain NASA Space Grant Consortium and the Naval Research Laboratory. The Starshine-3 satellite is a one-meter optically reflective sphere (it looks very similar to a disco ball!) covered with approximately 1500 aluminum “mirrors” that are one inch each in diameter. These mirrors were machined by technology students in Utah, with the grinding and polishing of the mirrors being accomplished by students in kindergarten through twelfth grade in schools around the world. The satellite can be tracked by the naked eye and students around the world will determine the coordinates of Starshine-3 and record their locations on the Starshine Project Internet web site. The resulting Starshine-3 data will provide scientists with new knowledge about how the Earth’s upper atmosphere reacts to fluctuations in the sun’s ultraviolet radiation during a sunspot cycle.

PICOSat was built by Surrey Satellite Technology Ltd, in Guildford, United Kingdom, and is to fly and operate four scientific payloads, Polymer Battery Experiment (PBEX), Ionospheric Occultation Experiment (IOX), Coherent Electromagnetic Radio Tomagraphy (CERTO), and Ultra-Quiet Platform (OPPEX). PBEX will test the flexible polymer battery for applications to space flight. The IOX uses Global Positional Satellite signals to measure ionosphere properties that impact communications and navigation signals. CERTO measures electron content of the ionosphere with the beacon signal and ground- based receivers. OPPEX demonstrates a passive and active vibration control for position-sensitive sensors.

The Prototype Communications Satellite (PCSat) is the first in an intended line of experimental satellites designed, constructed, and tested by midshipmen of the United States Naval Academy. PCSat’s function is to serve as a position/status reporting and message communications satellite for remote travelers using only hand-held or mobile radios.

The Sapphire satellite was built by the Space Systems Development Laboratory of Stanford University and also will be operated by the United States Naval Academy midshipmen. Sapphire will carry several experiments into orbit including a microchip that will convert text messages into a synthesized human voice to allow it to speak to listeners over amateur radio frequencies.

By Jeff Reddish/ASRC Aerospace/451

For additional information on WFF support of the Kodiak mission, please contact Steven Kremer/ GSFC Code 451 via email (steven.e.kremer.1@gsfc.nasa.gov).

New TRMM Orbit Will Extend Mission

The Tropical Rainfall Measuring Mission (TRMM) spacecraft will complete its fourth year of operations on 27 November 2001. The Flight Operations Team (FOT) achieved a benchmark operation this past August, when the observatory was raised to an operational altitude of 402.5 Km from 350 Km. This new orbit will extend mission life beyond mid-2003, when the observatory (at its previous altitude) would have reached the fuel level required for controlled reentry.

The orbit boost proved to be eventful. Three successive days of long Delta-V maneuvers (~235 seconds each) commenced on Tuesday 07 August, elevating TRMM by about 10 Km each day (six maneuver sets to achieve the 402.5 Km altitude were planned). The Friday 10 August boost was canceled to avoid interfering with the International Space Station (ISS) and a pending Shuttle launch to the ISS. TRMM management decided to operate at a transitional altitude of ~383 Km through the weekend, and continue boost operations on Monday after the Shuttle docked with the ISS. At that time, all instruments were operational and collecting good science data.

(continued on page 12)

(continued from page 11)

This plan, however, was interrupted on Sunday night August 12, when TRMM went into Sun Acquisition mode after onboard Earth Sensor data was marked bad. This event was not totally unexpected, as the higher altitude results in a lower signal-to-noise ratio. The situation was complicated by a sun interference value that had been continually increasing after the last maneuvers on Thursday, August 9. Although we always maintained communication and control of the spacecraft, science data collection was halted, with only health and safety telemetry data available.

What followed was a week of observation/analysis by the Mission Director, NASA engineers, personnel from Flight Software and Flight Dynamics, and the FOT. As a result of this analysis, TRMM management decided to switch to a backup attitude control algorithm (Kalman Filter), which neglects Earth Sensor input. TRMM transitioned back to normal operational mode, with instruments functioning on Friday August 17, with the contingency mode Kalman Filter operating in place of the Earth Sensors.

The FOT conducted nominal mission activities (albeit at 383 Km) until Tuesday and Wednesday August 21 and 22. At that time the FOT performed the final two long maneuver sets to achieve the new altitude. After an additional short duration maneuver set to round out the orbit was completed on August 24, the TRMM team declared the orbit raising a success, and the operation concluded.

The FOT continues to monitor overall spacecraft performance. All instruments are currently operating nominally, collecting a slightly different data set, due to the change in altitude. These data are being closely monitored since the backup attitude control algorithm is in use.

A TRMM follow-on mission is scheduled for the latter part of this decade. The probable gap in science data collection/study between the operation of TRMM and the follow-on will be reduced the longer TRMM can operate. It is expected that TRMM operations at the new altitude will decrease fuel expenditure, thereby extending mission life by as much as four to five years. The TRMM mission team is preparing to meet a controlled reentry requirement demanding 157 Kg of fuel. The amount needed for this boost (~40 Kg) should be recouped within a year operating at the new altitude. At this time, approximately 340 Kg of Hydrazine fuel remain.

By Lou Kurzmiller/TRMM FOT

For additional information regarding TRMM, please contact the author (lkurzmil@pop500.gsfc.nasa.gov) or Vickie Moran/ TRMM Mission Director (vickie.e.moran.1@gsfc.nasa.gov).

TILT "Ships" to the Arctic Again

The TDRSS Internet Link Terminal (TILT) is currently onboard the US Coast Guard Cutter Healy (WAGB 20) providing communications during the ship's Arctic East Summer (AES) '01 science mission in the Arctic Ocean. The Healy is designed to support research activities with laboratories and accommodations for up to 50 scientists. The TILT link allows the Coast Guard personnel and scientists to access the Internet while in the high northern latitudes, out of the view of any other communications satellite system. The Healy is supported by TDRS-1 via the White Sands Complex. Due to its high inclination, TDRS-1 is able to provide five hours of coverage a day to the North Pole, while in the northern portion of its orbit. TDRS-1 also continues to provide five hours of coverage per day to the South Pole TDRSS Relay (SPTR) during the southern portion of its orbit.

The TILT was placed onboard the Healy off the coast of Puerto Rico in early July 2001. The links were tested as the ship made its way north. The Healy expedition left Tromso, Norway on July 31 for a 60-day Mid-Ocean Ridge Expedition of the Gakkel Ridge, which is north of Svalbard. During this period the TILT provided connectivity for e-mail and other Internet applications that would not have been possible otherwise.

On October 2, the Healy returned to Tromso, Norway to re-supply and pick up a new science team. A second trip north will include tests of Autonomous Underwater Vehicles (AUVs) and a NASA JPL team will verify Arctic satellite imagery. The Healy is scheduled to complete its expedition and return to its home port in Seattle, WA in late November 2001.

More information about the USGC Healy and the AES '01 mission is available at *http://www.uscg.mil/pacarea/healy/.*

By David Israel/GSFC Code 567.3

For additional information, please contact the author via email (dave.israel@gsfc.nasa.gov) or telephone (301-286-5294).

TILT ventures into the Arctic onboard the US Coast Guard Cutter Healy

Expendable Launch Vehicle Update

Following a busy summer of expendable launch vehicle (ELV) missions, the schedule is starting to ease as we approach the end of the year. Not all has gone well during the summer; several missions experienced setbacks, with the most notable being the loss of two satellites during a Taurus launch on September 21. Orb View-4 and QuikTOMS were lost when the Taurus vehicle failed to achieve orbit. Orb View-4 was a commercial Earth-imaging satellite and NASA's QuikTOMS was to measure ozone level. For a more detailed account of this failure, see the article on page 15.

In another setback, Ariane 5 experienced a problem with its upper stage, resulting in two communications satellites being left in unusable orbits. Ariane 5 was launched from Kourou, French Guyana on July 12. NASA is currently working with CNES/ Arianespace to provide TDRSS support to Ariane 5/ ATV (Automated Transfer Vehicle) missions beginning in 2004. This failure may force the first ATV mission to move to 2005.

Not all the news was bad. The Japanese conducted a very successful launch of their first H-2A rocket on August 29. NASDA hopes to use the H-2A rocket to place a package on the moon in 2005. NASDA is currently working with NASA to obtain TDRSS support for that moon mission, the SELenological and ENgineering Explorer (SELENE).

Additional successes were achieved with Atlas and Titan launches delivering DOD vehicles to orbit.

Atlas 2AS rocket, carrying classified payload, punches through the clouds over Vandenburg AFB on September 8, 2001.

Photo: Tech Sgt Rodney Jones/ USAF

On deck is Atlas AC-143, which is scheduled to launch NASA's Tracking and Data Relay Satellite I later this year. Launch is currently planned no earlier than November 29. Also planned for later this year is the launch of Delta-2 with the French Jason-1 and NASA's Thermosphere-Ionosphere-Mesosphere Energetics and Dynamics (TIMED) research satellite. This mission is scheduled to launch from Vandenberg AFB on December 7.

By Joe St John/Lockheed Martin

For further information, please contact the author via telephone (301-805-3044) or email (joseph.stjohn@csoconline.com)

SN Provides Vital Support to MAP Mission

The Microwave Anisotropy Probe (MAP) observatory was successfully launched at 3:46 P.M. on June 30, 2001 aboard a Delta II 7425-10 three stage rocket. Its target in space was a Lissajous orbit about the L2 Sun-Earth Lagrange point, 1.5 million kilometers from Earth. The trajectory to the L2 orbit consisted of three phasing loops to position the MAP for a lunar swing-by and a two-month cruise to L2.

MAP arrived at the L2 Lagrange orbit on October 1, 2001. MAP is the first spacecraft to orbit this position. MAP will spend two years in the L2 orbit for its prime mission, with extensions to mission operations possible. The L2 orbit offers MAP a quiescent environment far from the thermal and electromagnetic perturbations of the Sun, Moon, and Earth. MAP's sun shield/solar arrays provide the instrument additional protection from these effects. All these steps are necessary for the instrument to achieve the microkelvin sensitivity required to generate a map of the cosmic background radiation—the faint afterglow of the Big Bang.

The MAP mission is to pick up where the Cosmic Background Explorer (COBE) left off. COBE detected small temperature variations in the cosmic background radiation. These tiny variations in temperature trace the beginnings of the galaxies we see today. MAP will revisit these variations with far greater sensitivity and resolution, providing scientists an opportunity to answer such basic questions as:

- How did the universe begin and how will it end?
- What constituents make up the universe and what is its shape?

(continued on page 14)

(continued from page 13)

- When did the galaxies first form and how?

MAP's flight hardware and software were produced in a partnership between GSFC and Princeton University. The Observatory weighs 843 kilograms and generates 419 Watts of power. Communications were provided initially via omni antennas and subsequently, as the distance from Earth increased, by a medium gain antenna. Reliability is obtained from redundant transponders and attitude control electronics and some onboard processor redundancy.

MAP's ground system consists of the Science and Mission Operations Center (SMOC) and a science data center, both located at GSFC. The SMOC system contains a combination of workstations and PCs supported by the Advanced Spacecraft Integration and System Test (ASIST) software system, and interfaces to the outside world by the Front End Data System (FEDS). Observatory operations conducted from these facilities include observatory state-of-health monitoring, data acquisition and processing, and attitude and orbit maintenance functions. The Deep Space Network (DSN) provides command and data handling support for the MAP mission using three deep-space communication facilities placed approximately 120 degrees apart around the world.

MAP was launched from the Kennedy Space Center with initial data acquisition occurring approximately three minutes prior to separation from the launch vehicle. This initial data collection was accomplished through the Space Network's Tracking and Data Relay Satellite (TDRS) and confirmed that successful separation had occurred. This SN support was crucial, because although the range had lost launch vehicle telemetry, the controllers in the SMOC were able to verify and announce nominal separation over the voice loop, thus preventing a potential destruct scenario. In spite of the loss of communications from the launch vehicle, the Delta placed MAP perfectly into its phasing loop trajectory.

With the spacecraft in view of the Madrid DSN station, a handover from TDRS to the station was conducted at the low data rate of 2 kbps. At completion of the handover, a high data rate was commanded by operations to downlink the data recorded during ascent.

After successful launch, most MAP subsystems were performance tested over a three day period, including thruster calibrations, checkout of ACS modes and sensor calibration slews.

A number of critical orbit maneuvers were required to position MAP correctly for the lunar gravity assist flyby. At the three perigee points during the phasing loops, MAP executed orbit adjust maneuvers critical for mission success. Due to the geometry of the orbit, no DSN station was in view for these critical burns. MAP used SN support to provide communications during these perigee events. The support of the entire SN was outstanding and enabled MAP to stay on its "golden trajectory." After the lunar fly-by, which brought MAP within about 5000 km of the Moon, two mid-course correction maneuvers were performed to trim MAP's trajectory for its orbit about L2.

With MAP now in its L2 orbit and the instrument in observing mode, the mission is going extremely well. Data acquisition continues to run at 100%. The first sky map is expected approximately December 2002. Everyone who has participated in the preparation for this significant event should take satisfaction in how flawlessly the mission has evolved. This is one well-behaved bird.

By Steven Coyle/GSFC Code 581 and Carl Gustafson/ITMI

To learn more about MAP, please visit the MAP home page at http://map.gsfc.nasa.gov/, or contact Steven Coyle via telephone (301-286-9335) or email (Scoyle@pop500.gsfc.nasa.gov).

TOPEX/Poseidon and the Upcoming Jason-1 Follow-on Mission

The U.S.-French TOPEX/Poseidon satellite continues to operate well, and the Project achieved its nine-year operational milestone in August. Attention is now focusing on Jason-1, the follow-on mission to TOPEX/Poseidon. Jason-1 is also part of an international partnership agreement between NASA and the French Space Agency CNES, and is scheduled to launch on December 7, 2001 from California's Vandenberg Air Force Base.

The Jason-1 satellite platform, primary altimeter instrument, and position-tracking antenna system were built and tested in France under contract through CNES. The spacecraft will also carry a radiometer instrument to measure water vapor, a Global Positioning System receiver, and a laser retroreflector array, which were manufactured in the U.S. through NASA. Weighing 500 kilograms (about 1,100 pounds), Jason-1 is approximately one-fifth the size of Topex/Poseidon.

Like TOPEX/Poseidon, Jason 1 is an oceanography mission designed to monitor global ocean circulation, study the ties between the oceans and atmosphere, improve global climate forecasts and predictions, and monitor events such as El Niño and ocean eddies. Jason-1 will continue to produce a contiguous, unique global view of the oceans that is impossible to acquire using traditional ship-based sampling. Project scientists have stated that each 10-day cycle of TOPEX/Poseidon satellite altimetry data provides more information than 100 years of prior ship-based measurements.

View of the Jason-1 satellite undergoing final testing at the Alcatel facility in Cannes, France. The radar altimeter antenna, which is just over a meter wide, can clearly be seen on the nadir portion of the instrument module.

Jason-1 will essentially measure the large and small hills and valleys of the ocean's surface, which allow scientists to calculate the speed and direction of ocean currents. Over time, these measurements will serve to provide a detailed assessment of global ocean circulation. Additionally, the world's oceans are Earth's primary storehouse of solar energy. Measurements of sea-surface height will reveal where this heat is stored, how it moves around Earth by ocean currents, and how these processes affect weather and climate. Jason-1 will also help measure long-term climate changes through very precise millimeter-per-year measurements of global sea-level changes.

Following a six month cross-calibration period between the two spacecraft, the orbit of TOPEX/Poseidon will be modified through a series of propulsive maneuvers to enhance overall science data quantity and quality. The flight team is currently preparing for Jason-1 operations here at the JPL Earth Science Mission Center, where we now monitor the TOPEX/Poseidon, ACRIMSAT, and QuikSCAT satellites. Although TOPEX/Poseidon has been operating for some time with several degraded or failed hardware systems, the operations team has been able to substitute redundant components or design operational alternatives in all cases. The Project remains optimistic that the spacecraft will remain healthy through the Jason-1 launch and calibration phases, and subsequently accomplish new objectives and milestones that were only imagined by oceanographers just a few years ago.

By Mark Fujishin/Manager, JPL Earth Science Mission Operations

For more information on either TOPEX/Poseidon or Jason-1, please contact the author via telephone (818-393-0573) or email (Mark.D. Fujishin@jpl.nasa.gov).

QuikTOMS Spacecraft Lost

The QuikTOMS spacecraft was to have mapped the distribution of the Earth's atmospheric ozone using the Total Ozone Mapping Spectrometer Flight Model 5 (TOMS-5) instrument. TOMS-5 was originally slated to fly on a Russian satellite, the Meteor-3M(2). When that mission was cancelled, NASA quickly formulated the QuikTOMS mission to convey TOMS-5, so that time-critical ozone monitoring could continue. Both the QuikTOMS spacecraft and its Taurus launch vehicle were procured from the Orbital Sciences Corporation (OSC).

Activities in the weeks prior to the September 21 launch gave no indication of the difficulties to come. Launch preparations, including the coupling of the QuikTOMS spacecraft to the launch vehicle, proceeded remarkably smoothly.

On the launch date, the OSC Taurus launch vehicle lifted off as scheduled from Vandenberg Air Force Base, California at 2:49 p.m. EDT. In addition to the QuikTOMS spacecraft, the launch vehicle carried Orbital Imaging Corporation's OrbView-4 satellite, a high-resolution and hyperspectral imaging satellite also built by OSC. The launch proceeded normally, until shortly after the separation of the launch vehicle's initial stage.

Approximately 83 seconds after launch, staff at the OSC control center in Dulles, Va, and NASA Select TV viewers observed the launch vehicle exhibit a severe yaw. In fact, it executed nearly a full 360 degree rotation, after which the attitude control system attempted to correct the launch vehicle's orientation. It is amazing that the Taurus vehicle remained intact during this spectacular maneuver, since it was not designed to withstand such forces!

After the launch vehicle appeared to correct its motion, it proceeded to jettison the fairings, and then to deploy the

(continued on page 16)

(continued from page 15)

QuikTOMS and OrbView-4 satellites. Unbeknownst to observers at that time, neither of the satellites was deployed at a high enough altitude to sustain orbit.

QuikTOMS was scheduled to be in contact with NASA's McMurdo Ground Station (MGS) approximately 23 minutes after launch. When the MGS did not receive a downlink from QuikTOMS, it became clear that orbit insertion had not been nominal. Immediately, the QuikTOMS Ground System Manager contacted CSOC staff at NASA's Alaska Ground Station (AGS) and asked them to deploy all available antennas to search for the lost QuikTOMS spacecraft. AGS provided the services of its 11-meter antenna, as well as one 8-meter antenna and one 2.4-meter antenna from the NASA Transportable Orbital Tracking System (TOTS) system.

In addition, the Ground System Manager declared a spacecraft emergency, activating NASA's Space Network to assist in the search for QuikTOMS. Simultaneously, staff at the Wallops Orbital Tracking Information System (WOTIS) facility began negotiating and rescheduling ground network resources to arrange for additional QuikTOMS support. All of these resources were coordinated in under 40 minutes—a credit to the dedicated staff involved!

In the mean time, the OrbView-4 satellite was not scheduled for ground contact until about one hour after launch. OrbView-4's launch team anxiously awaited information regarding the QuikTOMS satellite, with the hope that such information would help them to locate their spacecraft.

Despite the persistence of the NASA and contractor teams, none of the deployed resources were able to establish contact with QuikTOMS. Approximately two and a half hours after launch, NORAD informed the Ground System Manager that "multiple negative acquisitions" had been experienced for the deployed spacecraft (i.e. the spacecraft were never located). Early analysis from NORAD indicates that the spacecraft fell to Earth, landing in the southern Indian Ocean.

Although the exact cause of the launch vehicle failure has yet to be determined, OSC representatives indicate that they have a "primary suspect"—one of the launch vehicle's hydraulic actuator valves. These valves control the gimballing, or steering, of the Taurus vehicle. It appears that one of the valves may have become stuck in the wrong position for about 5 seconds, causing the vehicle's yaw motion. Analysts believe that there was a mechanical failure, as opposed to a software error, because telemetry data indicate that the correct software signals were executed to control the valve.

OSC asked NASA KSC Launch Services to assist in the examination of this anomaly, and by the first week in October had formed a team to investigate the situation. Conclusive results should be available after several weeks.

Information obtained from Raymond J. Pages/QuikTOMS Ground System Manager

For additional information on QuikTOMS, please contact Mr. Pages via telephone (301-286-6012) or via email (Raymond.J.Pages.1@gsfc.nasa.gov).

Aqua Team Prepares for Mission

As the Aqua launch approaches, personnel from many organizations are cooperating to ensure mission success. Engineers working on the Aqua spacecraft are currently conducting thermal vacuum testing, which has, to date, been successful. Ground Systems staff have completed extensive engineering interface testing and enhancement activities in preparation to support mission readiness testing. In fact, a Ground Network status review was conducted on October 11 to present recent enhancements, study team results, and test progress to the Aqua project, NASA Headquarters, as well as NASA Code 450 management.

Aqua will heavily utilize the Space Network (SN) to support its Launch And Early Orbit Phase (LEOP) activities. SN resources and personnel have been participating in numerous Aqua mission readiness test activities. Once LEOP is completed, nominal Aqua operations will require the SN to support daily passes to meet tracking requirements. Aqua will also use the Demand Access System (DAS) when the service becomes available (for more about DAS, see the article on page 27). Engineers continue to prepare for the temporary work-arounds needed to satisfy the Aqua requirement until DAS official operations begin.

NASA's Ground Network (GN) Polar stations at Alaska and Norway Prime will provide nominal support for Aqua operations after LEOP. As such, GN personnel have been supporting extensive engineering interface testing and mission readiness test activities. Demonstration of the capability to successfully flow X-band data through the polar stations to the new Polar Earth Observing System (EOS) Data and Operations System (EDOS) Ground System Interface Facilities (GSIFs), and then back to GSFC for further processing by the EDOS Level Zero Processing Facility (LZPF) was completed in August of this year. Engineers also enhanced the GN equipment to accommodate the Earth Observing System (EOS) Real-time Processing System (ERPS) equipment interface.

EDOS will be responsible for generating and distributing data products to various data centers for the Aqua mission. Teams have been conducting EDOS LZPF, Polar station GSIF, and WSC GSIF acceptance testing of new multi-mission support software and hardware capability in preparation for Aqua support. The system is currently being operated in a parallel posture, with the new multi mission capability as prime and the single mission capability acting as backup. EDOS continues to support Terra operations along with Aqua mission readiness testing, operations readiness testing, and testing with data centers supporting the Aqua mission.

In addition, the Network Integration and Analysis (NIA) team has been supporting documentation development, extensive engineering interface testing, mission readiness testing, and operations proficiency testing.

Artist's rendering of the Aqua spacecraft in orbit

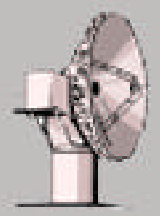
Watch for more news of Aqua mission progress in future issues of *The Integrator.*

By Teresa Murray/CSOC/EOS Customer Service Representative

For additional information, please visit the Aqua web site (http://aqua.gsfc.nasa.gov) or contact the author via email (teresa.murray@csoconline.com).

Another prospective MSP customer is the Ice, Cloud, and Land Elevation Satellite (ICESat) mission.

ICESat is scheduled for launch in 2002.



CODE 452

Operation Services Project

Network Control Center News

The Network Control Center (NCC) has significant operational accomplishments and several ongoing activities related to the implementation of the Data Services Management Center (DSMC) to report in this issue of *The Integrator.*

Since June 1, 2002, the NCC has supported seven Expendable Launch Vehicle (ELV) launches and two Shuttle missions.

NCC Data System (NCCDS) personnel delivered software releases SPSR M00.3D9 and CCS M01.2 (Ka WideBand) to operations on August 27 (see article on NCCDS maintenance efforts at the bottom of this page for more details). The M00.3D9 delivery fixed some customer interface problems, and the Ka Wideband delivery completes the NCCDS capability to process a new type of Space Network service associated with TDRS H, I, J.

The NCC transitioned from the NCC Maintenance Activity Report (NMAR) system to the CSOC Maintenance Management System (MMS) called MAXIMO. The EMU Technicians obtained training on the new reporting system, and the switchover was completed in June ahead of schedule.

The NCC Communications and Control Segment (CCS) Re-host delivery was completed on Monday, June 25. This delivery re-hosted the NCC CCS System Software on VAX 6600 systems, which are more compatible with the existing White Sands Complex (WSC) VAX equipment.

The DSMC transition has enabled the NCC to reduce the amount of physical space required at GSFC. Work continues on vacating Room 262 to provide space to house future tenants of Building 13. To date, approximately 2,120 square feet of space has been made available.

Remote NCCDS workstations at WSC are being successfully tested for access to the Auxiliary NCC (ANCC). The remote workstations will be used for pre-DSMC training and, eventually, for some remote operations.

In addition to providing support to our customers, personnel in the NCC will continue working to effect DSMC transition in the next several months.

By Joseph Snyder/ATSC

For additional information, please contact Bill Webb/GSFC Code 452 via email (bill.webb@gsfc.nasa.gov) or telephone (301-286-3264).

Additional details regarding the NCC Data Systems transition to the Data Services Management Center (DSMC) at the White Sands Complex are available on page 24.

NCCDS Maintenance Status and Future Plans

NCC personnel continue to prepare for the transition of the Network Control Center Data System (NCCDS) to the White Sands Complex (WSC). The NCCDS is to become the major component of CSOC's Data Services Management Center (DSMC). Part of the preparation for the transition included rehosting the Communications and Control Segment (CCS) and the NCC Test System (NTS) onto more appropriate hardware platforms.

The CCS Rehosting effort replaced the current VAX 8550 platform with a VAX 6610, which is a platform more compatible with the existing WSC VAX equipment. The CCS Rehosting effort has been successfully completed. NCC staff transitioned the new platform into operations on June 18, 2001.

The NTS Porting effort migrated the NTS to a platform that is more effective for the DSMC. The Operations Evaluation Test (OET) team completed and certified the new NTS system, which is now being used as the test system for the NCC and DSMC.

In addition, NCC staff have modified the NCCDS to support the NASA initiative to provide Ka "Wide Band " services. The team performed these changes in two phases due to the CCS rehosting effort described above. CCS Release M01.2, the baseline containing the Ka "Wide Band" Phase 2 changes, required modifications to both the VAX component and the HP component of the CCS. The OET team successfully verified these changes in July 2001 and transitioned into NCC Operations in August 2001. The NCCDS is now capable of fully supporting the Ka "Wide Band" demonstrations planned for later this year.

In conjunction with CCS M01.2, NCC personnel also developed and delivered an update to the Service Planning Segment Replacement (SPSR) baseline. They planned and implemented this update, SPSR M00.3D9, in response to several change requests from NCC Operations personnel. The changes are intended to increase NCCDS efficiency, which is increasingly more important as the DSMC transition approaches.

NCC staff are currently modifying the system to manage two new types of data transport. First, the addition of a Space to Ground Link Terminal (SGLT) at the Guam Remote Ground Terminal (GRGT) has driven an effort to add local interface data ports to that system. The port changes have been implemented in both the SPSR and CCS baselines, SPSR Release M01.1 and CCS Release M01.3, respectively. These baselines are currently undergoing independent testing, which is scheduled for completion in November 2001.

The NCC team is also modifying the system to provide Intermediate Frequency (IF) return services at Ku-Band. We are adding this type of data transport to the Space Network to support one of the first commercial TDRS customers, SpaceData Inc. (SDI). These changes are being implemented in SPSR M02.1 and CCS M02.1 with development of these changes due to be completed in late November 2001. Testing will then be conducted and is scheduled to be completed in March 2002.

By John Russell/CSC

For additional information, please contact Bill Webb/GSFC Code 452 via email (bill.webb@gsfc.nasa.gov) or telephone (301-286-3264).

GN Commercialization

Since the last issue of *The Integrator*, CSOC and NASA managers, along with their counterparts in Norway, have been busy finalizing plans to consolidate and commercialize operations at the Svalbard Ground Station (SGS) in Norway. CSOC presented the Svalbard Commercialization Commitment Document (CCD) to the Space Operations Control Board (SOCB) in September. The CCD summarizes the proposal for consolidation, highlights any risks, and provides NASA with a business case for commercialization. The SOCB approved the CCD, followed by a subsequent approval of the CSOC Delivery Order (this is the CSOC proposal to NASA for data services from Svalbard).

Following attainment of Department of State approval for transferring the property (no small feat!), the Svalbard consolidation and commercialization officially started on October 16, 2001. The contractor responsible for providing the services to CSOC and NASA is Space Data Services (SDS)—a Norwegian firm jointly owned by Norwegian Space Centre and Kongsberg SpaceTec.

However, SOCB approvals for a couple of documents were not all that was required to achieve this transition. In addition to the State Department approval noted above, CSOC personnel had to identify and tag all of the SGS property. With great assistance from Station Manager Reidar Norheim and Ken Griffin's staff at Wallops Flight Facility, all critical spares were identified and shipped to the site in August and September.

CSOC also worked closely with Steve Currier and Steve Kremer at Wallops to develop a new service loss metrics approach, and Gary Morse at SOMO came up with badly needed funding to replace the collimation tower that burned down last year. Then the Norway staff did a super job of installing the new tower in an almost impossible to reach spot on a mountain on the opposite site of Icefiord. In addition, the deals between Lockheed Martin and SDS and then between Lockheed Martin and NASA had to be negotiated. Needless to say the cooperation of many people was required to bring this transition about.

The final agreement has some interesting new features. The first is the service loss metric method mentioned above. In this approach, all scheduled services are measured (i.e., command, S- and X-band telemetry, and tracking). The total proficiency of all services delivered is then summarized on a monthly basis. If SDS

(continued on page 20)

(continued from page 19)

exceeds the proficiency requirements, CSOC pays a performance incentive for all passes during that month. If the proficiency is not met, there is a penalty for all passes. The service-based metric also provides CSOC, NASA, and NASA's customers a more comprehensive look at what went right and what did not during passes.

Another cost savings benefit of the agreement is that SDS is fully responsible for operations, maintenance, sustaining engineering, and logistics of all facilities at Svalbard. The last significant feature is that this is a Fixed Price agreement, based on price per pass. All in all, this arrangement fully meets NASA's objectives, and will provide high quality services at a reduced cost.

To finalize the process, a team of NASA and CSOC staff traveled to Norway in September. Members included Roger Flaherty and Steve Currier from Code 450, Alan Johns and Alexander Krimchansky from the ESDIS Project, and Dr. Doug Tighe, Chuck Gavaletz, and Bill Brooks from CSOC. The team spent Sunday and Monday meeting with the staff at Svalbard and touring the station.

At the time, there was a lot of activity up on the Svalbard plateau. SDS and the Tromso Satellite Station (TSS) are in the process of constructing another commercial antenna—a 13m Daytron. The partially constructed dome is visible in the accompanying photo. On Monday, construction crews were anticipating a strong storm, so they were busy strapping everything down and strengthening internal guy wires on the antenna panels. As we departed Monday afternoon, the storm had indeed arrived with strong gusty winds and the promise of lots of snow. At last report, the partially constructed dome held up well, and the Tromso Ground Station (TGS) antenna is scheduled to be in service in January 2002. Not shown in the photo are two additional pedestals for new antennas scheduled for completion next summer.

The antenna radomes at the SGS in Norway

From Svalbard, the team flew to Tromso where SDS and CSOC conducted a Transition Readiness Review for a board chaired by Roger Flaherty. The board noted that the site inspection went well. The board members approved the consolidated architecture and management approach, noting that they were pleased with the proactive management approach being taken by SDS. Finally, Mr. Flaherty noted that while proficiency has improved at both SGS and SKS, it is important for CSOC and SDS to continue this trend and provide customers with high quality data services.

The next step in GN commercialization will be to conduct a similar consolidation and commercialization of assets located at Poker Flat, Alaska. Honeywell DataLynx will be issued a Task Order for this activity in mid-October, with a planned activation date of December 2001. CSOC and NASA are also analyzing competitive proposals received from DataLynx and Universal Space Network for commercial services to replace the current MILA/PDL systems. That decision should also be made in November/December of this year.

Stay tuned as NASA and CSOC continue to break new ground in bringing commercial services online.

By Bill Brooks/Windermere ITS

For more details on the commercialization effort, contact the author via email (wbrooks@witusa.com).

Ground Network Prepares for EOS Mission Support

NASA's Ground Network (GN) will be supporting several upcoming Earth Observing System (EOS) missions. Specifically, the GN will support the Aqua mission (to be launched no earlier than late December 2001), the Ice, Cloud, and Land Elevation Satellite (ICESat) mission (scheduled for launch in 2002), and the Aura mission (scheduled for a June 2003 launch).

To prepare for the upcoming support of these missions, engineers at the two primary GN ground stations—the Alaska Ground Station (AGS) and Svalbard Ground Station (SGS)—installed 40 Mbps bit synchronizers for the ICESat mission, and 150 Mbps bit synchronizers for the Aqua and Aura missions.

An evaluation of the GN high-rate receiver and bit synchronizer capabilities was recently completed at both the AGS and SGS through extensive data flows of 40 Mbps and 150 Mbps science data both in short-loop and long-loop configurations. These data were sent to the ESDIS Ground Station Interface Facility (GSIF) and on to the EOS Data and Operations System (EDOS) for data capture and evaluation. The EDOS, having generated the source data for testing, was able to verify the completeness and quality of data sent by the GN stations. The tests revealed some ground station cabling problems that were later corrected. At the conclusion of the test activities, the ground stations were declared ready for the next segment of mission testing—the Mission Readiness Test Team (MRTT) requirements testing.

GN resources and personnel have also supported Joint Engineering and Mission Operations Science Support (MOSS) testing, the most recent of which was the joint Aqua/ICESat MOSS-5 test activity. MOSS-5 testing includes the flow of science data (X-band) from the supporting GN stations and the commercial polar ground stations to the GSIF (located at the polar sites), to the EDOS (located at GSFC), and then to the higher level science data processing facilities. Pass profiles and durations for this test are similar to that of real pass data capture times and sequences in a multi-mission environment.

The GN is currently participating in Mission Readiness Testing for both the Aqua and ICESat missions. Engineers have tested and verified all GN S-band mission requirements for Aqua. Next, they will conduct detailed X-band long-loop mission requirements testing for Aqua. Verification of GN S-band and X-band mission requirements for ICESat will also be conducted starting in mid October 2001.

By Lou Koschmeder/ITT Industries

For more information on this topic, please contact Steve Kremer via email at steven.e.kremer.1@gsfc.nasa.gov or via telephone at (757) 824-1114.

Pacor-A Level-Zero Processing System Now Operational!

The Pacor Automation (Pacor-A) level-zero processing system is now in full operations for the Tropical Rainfall Measuring Mission (TRMM), Hubble Space Telescope (HST), and Upper Atmosphere Research Satellite (UARS) missions. TRMM transitioned on July 23, the HST mission on August 7, and the UARS mission on October 1. The three transitions proceeded smoothly, and Pacor-A is now providing all science data capture, level-zero processing, raw data and product archiving, and data distribution functions for these missions. The ERBS mission is also scheduled to transition to Pacor-A in the next few months.

The Pacor-A team designed the system to reduce the cost of providing level-zero processing services to these four on-orbit missions, and to provide the basis for level-zero processing services to future missions. Pacor-A accomplishes these goals by consolidating system operations, automating their operations, and eliminating the custom hardware and aging computer systems previously in use.

Instrumental to the successful implementation of Pacor-A was the innovation, dedication, and teamwork of the CSOC engineering and operations organizations. The team worked diligently to develop and test the system to ensure the data products were of similar or higher quality than the legacy systems, and that the system could be operated with greatly reduced staffing levels.

With the implementation of Pacor-A, many of the legacy systems currently supporting the HST, TRMM, UARS, and ERBS missions will be decommissioned. Specifically, the Generic Block Recording System (GBRS) and Generic Recording System (GRS) are no longer required for routine operations. Once ERBS transitions to Pacor-A, the TDRSS Interface Preprocessor Into Telops (TIPIT), IBM

(continued on page 22)

The Pacor-A Ops Team

Pictured (left to right) are: (front row) Terri Stoner, Sharon Wanzer, Cindy Leaper, Christine Marinaccio; (back row) Felecia Glaude, Andrei Stewart, Carl Sylvis, Carl Henning

(continued from page 21)

Level Zero Processor (LZP), Unisys Clearpath, and Data Distribution Facility (DDF) systems will no longer be required. Elimination of these systems will result in a significant cost savings.

Pacor-A team members are proud of their accomplishments, and look forward to the successful transition of the ERBS mission to Pacor-A during the next few months.

By Brian Repp/HTSI

Please contact the author via telephone (301-286-3699) or email (Brian.D.Repp@gsfc.nasa.gov) for more details.

CSOC Reorganization Underway

Last Spring, Lockheed Martin Space Operations (LMSO) officials announced that the company would be reorganizing its Consolidated Space Operations Contract (CSOC) with NASA. Under CSOC, LMSO and several subcontractors provide end-to-end space operations and mission and data services to NASA's customers.

The reorganization will decentralize the management of CSOC operations, empowering CSOC managers at each NASA center with day-to-day operations responsibility, authority, and accountability, in addition to budget authority. The reorganization is designed to optimize service levels and cost savings, and increase responsiveness to customers.

A CSOC Associate Program Manager at each NASA center will be responsible for operations, engineering, project implementation, business support, customer service, safety, and other support functions at the center. LMSO has designated the Associate Program Managers for the respective NASA centers as follows:

- Goddard Space Flight Center – Phil Johnson
- Johnson Space Center – Dan Brandenstein
- Jet Propulsion Laboratory – Isaac Gillam
- Kennedy Space Center – Brian Duffy
- Marshall Space Flight Center – Grady Sherman Jobe

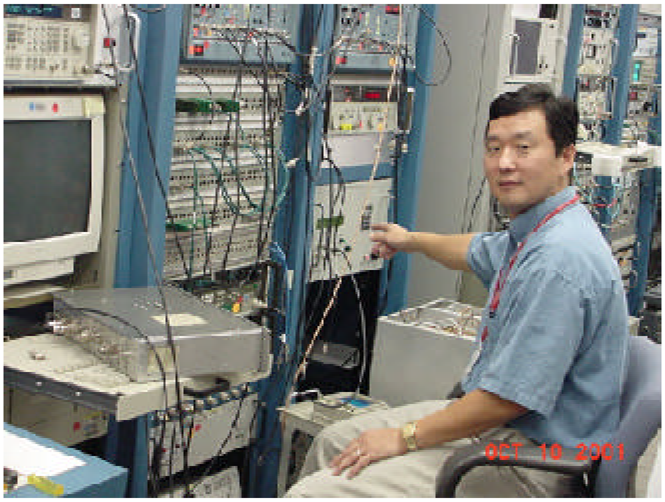
Appointment of additional members of the CSOC GSFC management team was completed July 9, 2001. Chuck Gavaletz has been appointed the GSFC CSOC Commercialization Manager, with Greg Troendly as the IDIQ Technical Officer. Additionally, Bruce Emmel has been appointed Manager of Center Services, overseeing the areas of Health and Safety, Training, Documentation, Property, Logistics and Security.

Ka-Band Technology at Goddard

The Radio Frequency Simulations Operations Center (RFSOC) is the site of a unique Ka-band development effort at the Goddard Space Flight Center (GSFC), through the auspices of the Consolidated Space Operations Contract (CSOC). Under the direction of Fred Gams, the RFSOC is making significant progress in putting together a fully functional Ka-band test system. This system's main components include:

- 5.6-meter antenna with dual-polarized Ka-band feed procured by CSOC from Technical Systems Associates (TSA) in Orlando, FL
- Two ultra-high rate wide-band demodulators built by Honeywell Technology Solutions Inc. (HTSI), designed to recover data in both BPSK and QPSK formats
- Bit error rate test equipment from Agilent and SyntheSys Research capable of operating at data rates up to 1 Gbps
- RF carrier modulator built by HTSI that receives external I and Q channel mixer driver signals and a Ku-band carrier (14.900 GHz) and generates a BPSK or QPSK modulated output signal at a fixed power level
- Ka-band Intermediate Frequency (4.850 GHz) to Ka-band (26.380 GHz) upconverter built by MITEQ with a 7.0 dB noise figure, along with excellent phase and amplitude linearity characteristics

5.6 meter Ka-band antenna (on right) developed by CSOC for TDRSS relay testing from RFSOC



Yonwoo Nam of HTSI, a principal designer of the ultra-high rate wideband demodulator, conducts testing at the RFSOC

In addition to the above items, certain key elements of this Ka-band system have been designed and built in-house at the RFSOC, including:

- Carrier generator which produces a 14.900 GHz RF carrier that is tunable over a 230 MHz range in 0.07 Hz steps
- Ku-band (14.900 GHz) to Ka-band Intermediate Frequency (4.850 GHz) downconverter which is amplitude and phase linear over a 125 dBc/Hz C/N_o range
- L-band (1.2 GHz) to Ka-band Intermediate Frequency (4.850 GHz) upconverter
- Verification downconverter which consists of two sections:
  - Ka-band (26.380 GHz) to Ku-band (14.900 GHz) downconversion section located on the antenna
  - Ku-band (14.900 GHz) to L-band (1.2 GHz) downconversion section located within the RFSOC operations area

A subset of this Ka-band system has already been utilized to check out a high data rate test modulator that was purchased for the Ka-Band Transition Product (KaTP) effort at the Wallops Flight Facility (for more on the KaTP, see the article on page 28). In addition, certain portions of this RFSOC system will be used to test the Ka-band phased-array antenna procured by Code 567.

Next year the RFSOC will be capable of supporting GSFC development laboratories using the Ka-band system as the RF simulator for local testing. Once one of the new generation of Tracking and Data Relay Satellites (i.e. TDRS 8, I, or J) is positioned such that the RFSOC can view it, GSFC will have direct access at Ka-band for Space Network testing. Together with the KaTP effort, this new capability at the RFSOC ensures that GSFC will be at the forefront of NASA's Ka-band testing for years to come.

Portion of the Ka-band return link system under development at the RFSOC

By James A. Braun/HTSI

For additional information on this topic, please contact the author via telephone (301-805-3842) or email (james.braun@honeywell-tsi.com).

Making Bit Error Rate (BER) measurements through RFSOC's Ka-band system

CODE 453

Technology and Upgrades Project

Data Services Management Center Phase-Over Begins

Implementation of the Data Services Management Center (DSMC) at the White Sands Complex in New Mexico remains on schedule, with the recent successful completion of the Ground Network (GN) Legacy Scheduling Operational Readiness Review held October 17. A phase-over will begin October 25, with the DSMC assuming responsibility for GN scheduling in week 46, including scheduling responsibilities for the following systems:

- Wallops and Alaska LEO-T 5m
- Wallops and Alaska TOTS 8m
- Wallops 7.3m
- Wallops 7.3m Meteosat

The following set of customers will be utilizing these resources to interface with the DSMC, effective October 25:

- SMEX (FAST, SWAS, SAMPEX, WIRE, TRACE)
- SNOE
- Meteosat
- FUSE
- TOMS-EP
- SOLAR
- Seawifs
- IRS-P3

A network advisory message will be sent detailing the activities associated with the phase-over.

The GN automated system and customer base is scheduled to transition to the DSMC on January 24, 2002. Customers will be contacted shortly to participate in testing.

Shuttle scheduling and the emergency/contingency set of customers (TRMM, HST, ERBS, LSAT-5, GOES, TDRS), the final portion of the GN scheduling effort, will transition to the DSMC with the phase-over of the 9M antenna systems at Wallops, MILA and Santiago. This transition is tentatively planned for mid February 2002, and is dependent on the mission dates for STS 108 and 109.

Transition of the WSC TCP/IP Data Interface Service Capability (WDISC) is planned for December 14, 2001, and the Network Control Center Data System (NCCDS) transition is planned for February 18, 2002. Now that the DSMC has a connection to the closed IONet, customer engineering interface (EIF) testing can commence. Space Network customers will be contacted to schedule participation in these tests.

By Cathy Barclay/HTSI

For additional information on this topic, please contact the author via email (Cathy.Barclay@gsfc.nasa.gov) or telephone (301-805-3221).

GSFC Personnel Participate in CCSDS Panel 2 Activities

The Consultative Committee for Space Data Systems (CCSDS) is an international organization, whose members seek to exchange technical information regarding common space data transport and information interchange problems. CCSDS members work to agree upon optimized solutions (called CCSDS Recommendations) to such problems, and to promote the implementation of these solutions.

In this article, we will discuss the recent activities of CCSDS Panel 2. Panel 2 is specifically chartered to investigate the processes of preserving and interchanging space-related information among autonomous, distributed, and heterogeneous systems when there is wide variation in the time between generation and the application of said information. Its main objectives are to identify which of these several processes are suitable for standardization, identify existing international standards to adopt or adapt where appropriate, and enlist the aid of the space community in developing the necessary specifications.

CCSDS Panel 2 has developed many recommendations in the areas of data packaging, data description, and data administration. The most recent of these recommendations is the Data Entity Dictionary Specification Language (DEDSL) family of recommendations. These recommendations specify a language that enables a data provider to describe the semantics of his products, and enables a scientific discipline to create a data dictionary that specifies the semantics of commonly used data elements. The DEDSL family of recommendations includes an abstract syntax specification and several concrete specifications that map the abstract syntax into common data description languages. Currently, the abstract specification and a Parameter Value Language (PVL) concrete syntax are Blue Books (i.e., approved specifications) and an Extensible Markup Language (XML) Document Type Definition (DTD) specification is undergoing CCSDS review. Panel 2 members are currently working to incorporate XML technologies to create a new generation of packaging and data administration recommendations that take advantage of this rapidly growing technology.

CCSDS Panel 2 is also active in the area of Archiving Standards. A new version of the Open Archival Information Systems (OAIS) reference model is currently undergoing a two month International Organization for Standardization (ISO) and CCSDS review for final approval as an ISO International Standard. This new version incorporates the resolution of comments made during the first review cycle, and it is anticipated that it will be approved before the end of 2001. The OAIS reference model has proved to be an essential starting point for international agreements for the preservation of digital information, and earlier versions have been used as the basis for numerous academic, governmental, and commercial efforts in this domain. Currently, CCSDS Panel 2 is also developing a methodology for the interactions between a data producer and an archive. There is also an effort underway to define an archive certification work package.

By Lou Reich/CSC and Donald Sawyer/GSFC Code 633

For further information, please contact Donald Sawyer, GSFC P2 representative, at 301-286-2748 or visit the Panel 2 web pages (http://www.ccsds.org/p2/).

Position Determination Studies Benefit MSP Customers

Increasingly rigorous science requirements dictate that the position and orientation of satellites must be determined more and more accurately. To meet these requirements, advancements must be made in the fields of attitude determination and sensor calibration. A team of civil servants and contractors in GSFC Code 572 is undertaking several studies to advance this technology. These studies, which are sponsored by the Technology and Upgrades Project (GSFC Code 453), include investigation of improvements in the methods by which sensor measurements and reference data are efficiently processed to determine attitudes.

A large portion of this research is centered on finding how attitude errors can be reduced through the in-flight calibration of the sensors, and on developing new calibration algorithms and subsystems. These studies evaluate how random and systematic errors affect attitude accuracy, and compare the results of different attitude determination algorithms using in-flight as well as simulated data. Also, these studies investigate spacecraft attitude control behavior and its application to attitude determination, attitude prediction, and spacecraft design.

One of the prime tools the team utilizes for these studies is the Multi-Mission Three Axis Stabilized Spacecraft System (MTASS). This system was developed using the MATLAB? programming language, which is a primary tool for engineering analysis in both universities and industry. Since we develop and test our analysis algorithms in MATLAB? , they are much easier to move into the MTASS system, where they are available to all missions.

Previous studies emphasized improving the accuracy, speed, and ease of use of the calibration algorithms, as well as researching algorithms that take advantage of low cost, reliable, and less accurate sensors such as magnetometers. In the past, sensor calibration for a given satellite required a relatively large team of personnel and could take two or more weeks to complete, due to the unwieldy mainframe-based software system and the cumbersome algorithms utilized. The same calibration can now be accomplished with 1-2 people in a few days. The use of MTASS has greatly contributed to this efficiency, as have the newly developed algorithms described below.

(continued on page 26)

(continued from page 25)

The magnetometer calibration system was the first system "overhauled." The Code 572 team developed a new algorithm, which estimates magnetometer scale factors, misalignment, and bias, as well as the torquer bar contamination matrix. They used this new algorithm to successfully calibrate the RXTE magnetometer, which the older mainframe algorithm was unsuccessful in calibrating. This same algorithm was recently used to successfully calibrate the TRMM magnetometer.

Gyro calibration was the next system to be enhanced. The previous algorithm could only use sensor observation (such as star trackers) before and after each maneuver—all other observations were ignored. That system also required separate attitude estimates before and after each maneuver. The team designed the new algorithm (called the Batch IRU Calibration Utility or BICAL) to estimate not only gyro alignment, scale factors, and bias, but also attitude. As a result, all potential sensor observations are used, and the attitude and gyro calibration process is combined. This algorithm results in a more accurate solution that requires far less time to generate. One of the first missions to use this algorithm was the WIRE spacecraft. The pre-calibration attitude propagation errors, which are typical, can be seen in Figure 1. The post-calibration attitude propagation errors can be seen in Figure 2. BICAL was most recently used for the MAP mission.

Sensor alignment estimation was the next utility the team refurbished. The new alignment utility, called Alignment Calibration (ALICAL), is faster, more accurate, and processes

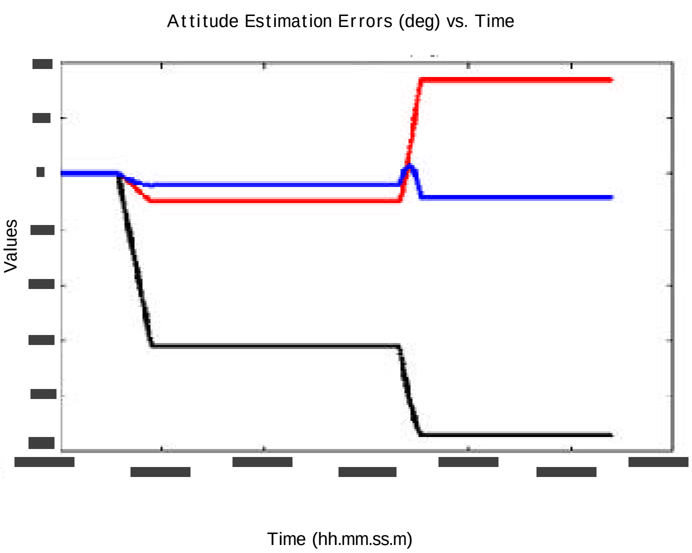


Figure 1. WIRE pre-calibration attitude propagation errors

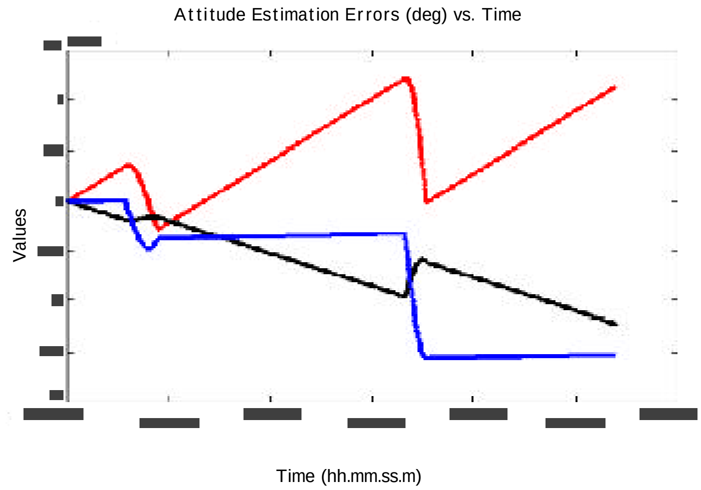


Figure 2. WIRE post-calibration attitude propagation errors. (*Note the values on the y-scale are multiplied by 10^{-3}*)

more sensors than the previous utility. Recently, ALICAL was used in the MAP mission (see article on page 13), whose sensor complement includes two quaternion star trackers and two fine sun sensors.

The Code 572 team also improved methods used for gyroless rate estimation and magnetometer navigation. Over the past few years, such algorithms have been refined to estimate rate from sensor observation vectors (i.e., magnetometers and sun sensors), as well as quaternion trackers. The MAP mission recently used a merged version of this algorithm. During each of the three perigee orbit maneuvers MAP executed, the spacecraft's two quaternion star trackers became inoperable, due to interference from radiation belts. If a gyro had failed during these maneuvers, the onboard attitude estimate would need to have been quickly re-initialized or MAP would have missed a critical orbit maneuver. The availability of the newly developed algorithm ensured that such a re-initialization would have been successful, if it had been required. Typical ground rate and attitude estimation results using the algorithm for MAP are shown in Figure 3.

The team has also studied magnetometer navigation in depth for the past three years. Magnetometers are flown on every low Earth orbit (LEO) mission for momentum management purposes, and in some cases, for coarse attitude estimation. These sensors have the advantage of being inexpensive and reliable. The goal is to estimate spacecraft attitude, rate, and orbit, using magnetometers as well as sun sensors. This navigation estimate (MAGNAV) could be useful to missions with modest navigation requirements, or as a backup for missions with more stringent requirements. Such an algorithm was successfully applied to the

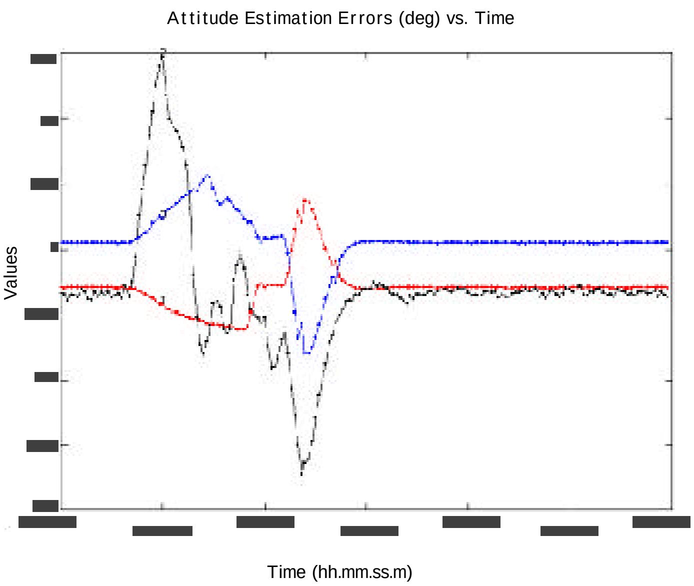


Figure 3. MAP ground attitude estimation errors during perigee orbit maneuver

TRACE and WIRE missions using flight data. Currently, the algorithm is being implemented in the WIRE flight software which will be loaded onto the spacecraft onboard computer this year and run as an experiment. In addition, the team has recently incorporated GPS measurements into MAGNAV analysis.

Now that the calibration algorithms have been enhanced, our focus is shifting toward automation of these processes—which should achieve significant cost savings. The calibration process can be automated both on the ground and onboard the spacecraft. The advantage of performing the processing on the ground is that higher caliber algorithms can be developed. The advantage of onboard spacecraft calibration is spacecraft autonomy. It is expected that both methods will need to be developed to cover all future scenarios.

By Rick Harman/GSFC Code 572

For additional information on this effort, please contact Tom Stengle/GSFC Code 572 via email (tstengle@pop500.gsfc.nasa.gov).

Demand Access System

The Demand Access System (DAS) is being built by ITT Industries in Reston, Virginia with systems engineering support provided by CSOC personnel at GFSC and at the White Sands Complex (WSC) in New Mexico. DAS will expand existing Space Network (SN) Multiple Access Return (MAR) system capabilities by building on the successful deployment of the Third Generation Beamformer System. DAS will add customer service configuration and monitoring capabilities, new demodulation capabilities and TCP/IP based CCSDS data distribution capabilities via the NISN IONet.

DAS, in conjunction with the SN Web Services Interface (SWSI), will provide longer contact times for customers enabling new opportunities for the SN customer community. The last issue of *The Integrator* (July 2001) provided an overview and update of the technical features and capabilities of DAS. This issue contains an update on DAS development and an overview of how customers can obtain service.

The DAS product development team successfully completed several key document milestones that are important to finish development and integration. Foremost in this list is completion of the Interface Control Documents (ICDs) for SWSI and DAS customers. These two ICDs join the WSC ICD dated 15 February 2001, to provide a complete description of how DAS connects to outside resources and to its customers via NISN.

(continued on page 28)

The DAS equipment racks in Reston, VA

(continued from page 27)

In addition to the ICDs, the DAS security plan was approved, paving the way to operate within both NISN and WSC secure networks. Finally, some operator friendly "ground rules" are being developed to help educate customers on DAS's "personality" and how it will operate through SWSI. These ground rules detail many different aspects of DAS operations and how customers will need to configure SWSI and DAS to execute services successfully. These milestones were accomplished with contributions from NASA, the implementation contractor, and CSOC at both GSFC and WSC.

The DAS team has finished reviewing final hardware configurations and some software code. CSOC-WSC personnel have been particularly instrumental during these reviews. DAS is now poised to enter factory integration and testing, with a target WSC operations date in April 2002. Once DAS is accepted for operations, customers can subscribe for service by coordinating with the Customer Commitment Office in Code 450.

Missions that identify DAS as a potential service provider should begin the subscription process 18 to 24 months prior to requiring service. The Customer Commitment Office and the potential customer will participate in loading and RF compatibility analyses to ensure DAS will meet some portion of a mission's requirements. This early part of the process concludes with negotiations of a Project Service Level Agreement (PSLA). The PSLA may require additional resources for the DAS equipment pool to support the new customer, and simultaneously maintain existing service commitments to its current customers. One of DAS's major advantages is its ability to expand over time to potentially support as many as 50 simultaneous customers.

In the months before operations begin, a database administrator at WSC will populate both DAS and SWSI databases for the new customer. If required, NISN will assist the new customer with gaining necessary access to the Closed IOnet or a local interface. At this point the new customer should be ready to begin testing, prior to real-time operations with DAS.

DAS customers may plan MAR service requests up to several years into the future through SWSI. All that is required from a customer is simply refreshing the state vector when required.

Two typical examples of potential DAS customers are single spacecraft requiring a continuous real time downlink, and formation flyers made up of multiple spacecraft grouped closely in the same orbit. Each requires a different service request and DAS configuration to provide service. The continuous DAS customer can receive 24 hour a day service by submitting three separate, simultaneous service requests covering TDRS-East, TDRS-West and TDRS-ZOE (Zone of Exclusion). For each day service is requested, DAS determines the best mix of TDRS visibility and hardware availability to provide continuous coverage. A continuous DAS customer may see a data loss of up to 15 seconds each time DAS must shift a beamformer from one TDRS to another.

Formation flyers requiring continuous coverage will use a similar process. As with single spacecraft customers, formation flying missions must submit separate service requests for each platform, so DAS can assign enough resources. Internally, DAS will utilize several demodulators to cover each of the corresponding spacecraft to support this type of mission under the same MA beam.

By Thomas Gitlin/GSFC Code 453

To learn more about the DAS operating concept and additional operations planning details, please visit our web page at (http://stelwscpo.gsfc.nasa.gov/Das/), or contact the author via telephone (301-286-9257) or email (tgitlin@pop500.gsfc.nasa.gov).

Ka-Band Transition Product Status

In early 2000, NASA/GSFC established the Ka-Band Transition Product (KaTP) to design and develop the necessary network infrastructure for demonstrating interoperable Space Network (SN) and Ground Network (GN) Ka-band data services. Project staff are currently implementing a new Ka-band ground station for the GN at Wallops Flight Facility (WFF), and modifying the SN ground stations at the White Sands Complex (WSC). When the implementation is complete in mid 2002, high data rate demonstrations (up to 600 Mbps) will be performed using a GSFC developed (Code 564) high data rate receiver and a test transmitter. The project will provide the results and impetus to guide the future direction for Ka-band data service provisioning.

SN Modifications

The SN ground terminals at the WSC will be upgraded to take advantage of the new TDRS H, I, J spacecraft 650 MHz-wide Ka-band space-to-space return link in the 25.25 GHz to 27.5 GHz band. The WSC ground stations are presently capable of supporting Ka-band customers via TDRS H, I, J at data rates up to 300 Mbps, using the 225 MHz-wide Ka-band space-to-space return link channel. The KaTP will implement a prime and redundant 650 MHz-wide Intermediate Frequency (IF) service at four of the five Space-Ground Link Terminals (SGLTs) by adding new downconverters and equalizers. The downconverters will receive the 650 MHz-wide downlink signal from TDRS H, I, J spacecraft, and output a 1200 MHz IF signal. The new 650 MHz-wide downconverters have been specified for compatibility with the Space Networks Interoperability Panel (SNIP) Ka-band return frequency plan. Modifications are also being made to the existing 225 MHz-wide downconverters to enable SNIP frequency plan support. Compatibility with the SNIP frequency plan will allow for future cross-support with European Space Agency (ESA) and Japanese (NASDA) missions.

New GN Systems

A GN demonstration system will be installed at WFF with the capability to support S-Band command (2025 to 2120 MHz), S-band telemetry (2200 to 2300 MHz), and Ka-Band telemetry (25.5 to 27.0 GHz). The system will consist of 5.4 meter X-Y mount antenna housed in radome with a Ka-band cassegrain feed and an S-band prime focus feed. The Ka-band ground station equipment will provide an IF output at 1200 MHz with an interface identical to the SN Ka-band IF output. The ground station will be used for test and demonstration purposes only, and therefore will be implemented with limited remote monitor and control capabilities.

High Data Rate Demonstrations

Upon completion of the SN and GN modifications for the KaTP, high data rate demonstrations will be performed to demonstrate the networks' capability to support Low Earth Orbiting (LEO) spacecraft operating at data rates up to 600 Mbps. The main objectives of the KaTP demonstrations are to:

1. Characterize the performance of the physical return links at rates up to 600 Mbps (GN direct-to-earth Ka-band downlink, and SN return Ka-band link relayed via TDRS H or I)

2. Characterize the acquisition and tracking performance of the GN Ka-band antenna

3. Assess the effects of hardware distortion on the overall link

4. Characterize the GN and SN system designs

5. Provide an end-to-end system (i.e., "reference link" or test system) to help characterize new high rate Ka-band hardware.

The demonstrations will assess the RF link performance via measurements of bit error rate and the signal spectra. A high data rate test modulator (600 Mbps, Staggered Quadrature Phase Shift Keying), procured by the KaTP project, will be used in conjunction with the GSFC developed (Code 564) high data rate receiver to support the demonstrations. The SN demonstration (illustrated in Figure 1) will use the TDRS H or I spacecraft to relay a simulated customer signal to an SGLT at the WSC. On-site test equipment will be used at WSC, including the existing Ka-band Single Access Test Antenna System used to verify the TDRS H Ka-band 225 MHz-wide space-to-space return link.

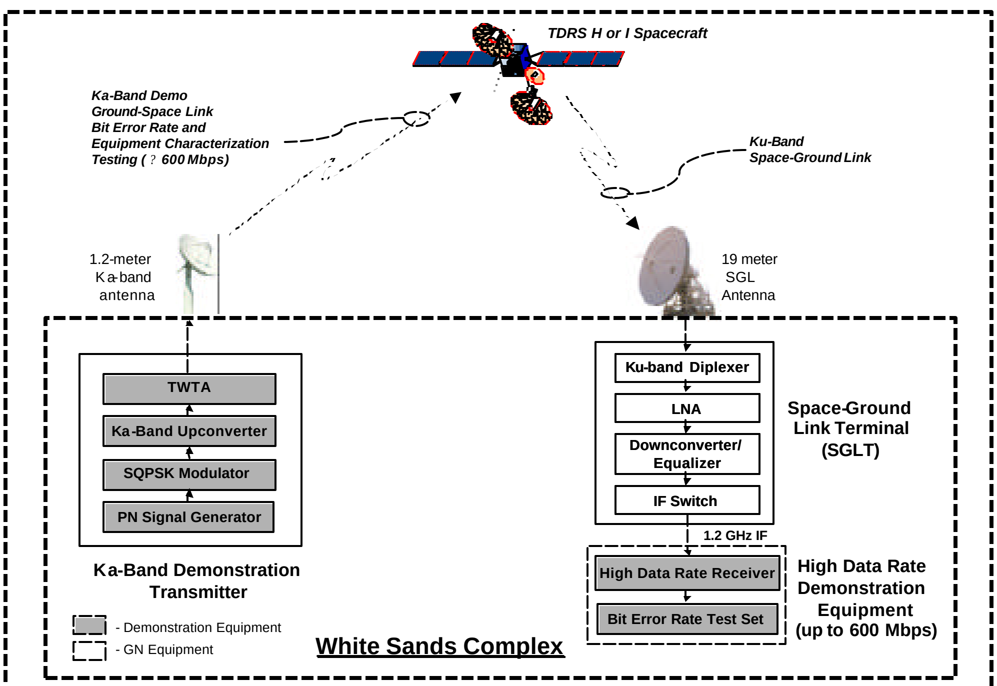


Figure 1. Depiction of the KaTP Space Network Demonstration

The GN demonstration (see Figure 2 on page 30) will consist of a boresite antenna and a high rate transmitter to provide a signal source for bit error rate (BER) testing. The GSFC developed Ka-band phased array antenna may also be used as a signal source for the GN demonstration, if feasible. Use of a NASA aircraft to demonstrate that the GN Ka-band antenna can successfully acquire and autotrack a customer spacecraft with Low Earth Orbit (LEO) range dynamics is also being investigated. The KaTP project will also investigate the use of potential targets of opportunity such as the ENVISAT spacecraft for the Ka-band demonstrations.

(continued on page 30)

(continued from page 29)

KaTP Milestones

Project personnel conducted a system design review in December 2000 and are currently performing hardware acquisition and integration activities. GN acceptance testing is scheduled for the January 2002 timeframe, and SN acceptance testing is scheduled for the July 2002 timeframe. Initial GN and SN demonstrations will occur in the spring of 2002. The initial demonstrations will be performed at low data rates (under 300 Mbps) to verify the test equipment, test set-ups, and test procedures. The high data rate SN and GN demonstrations are presently scheduled for the fall of 2002.

By Mark Burns/ITT Industries

For further information contact Yen Wong (301-286-7446) or Roger Clason (301-286-7431).

KaTP acceptance testing for the GN is "scheduled for the January 2002 timeframe, and SN acceptance testing is scheduled for July 2002."

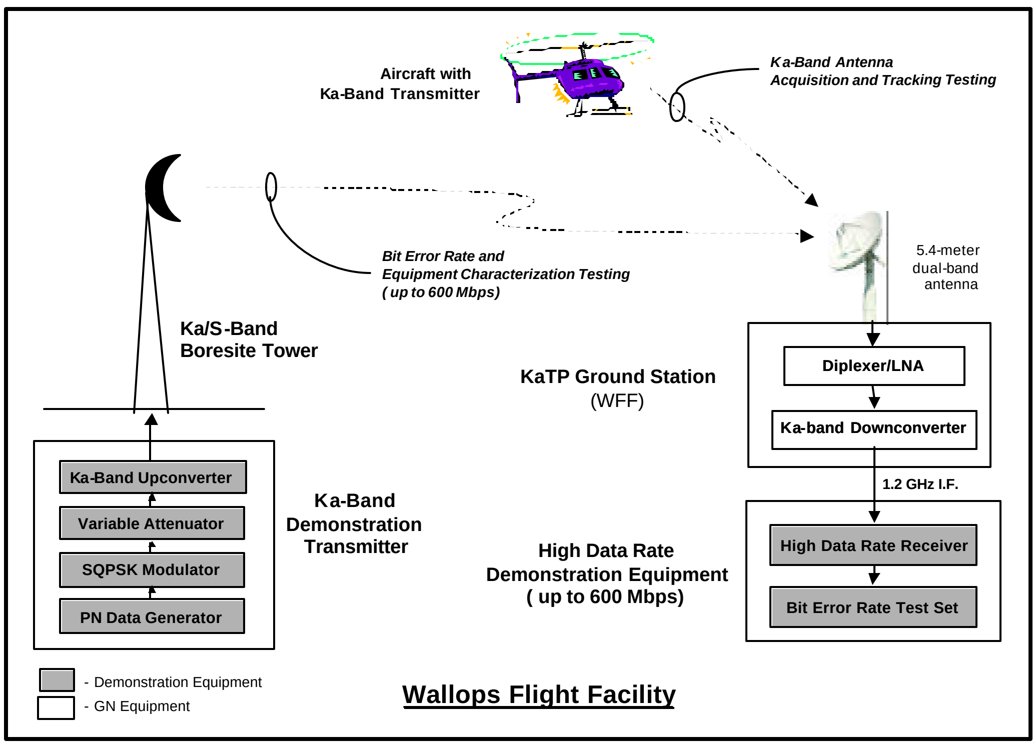


Figure 2. Depiction of the KaTP Ground Network Demonstration

TDRS Project

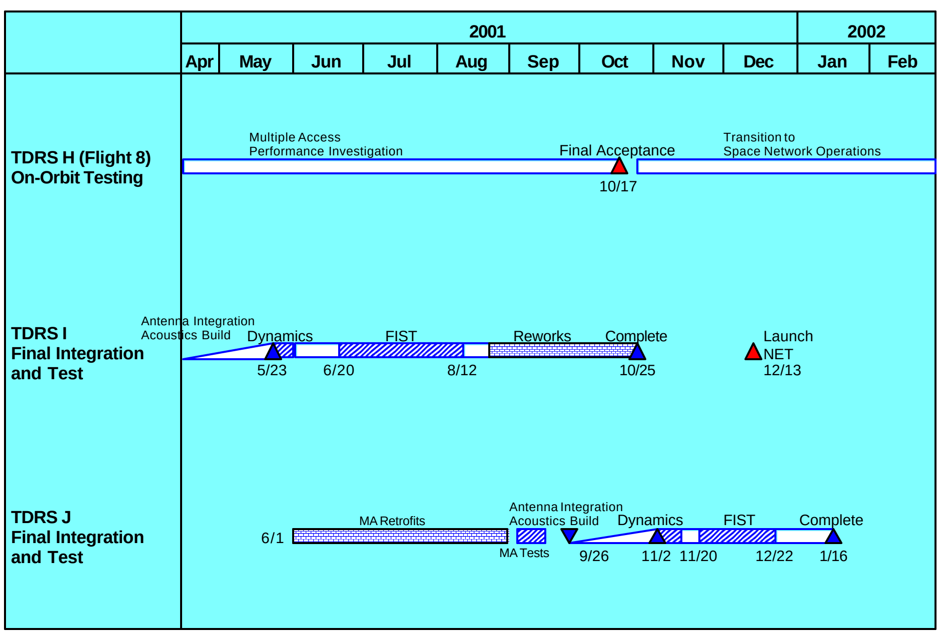
NASA Accepts TDRS-H

On October 17, 2001, NASA accepted the TDRS-H spacecraft, which was launched on June 30, 2000. With this event, the White Sands Complex Maintenance and Operations contractor assumed control and day-to-day responsibility for TDRS-H (now known as TDRS-8) on behalf of the Operation Services Project. The plan is to relocate the satellite to an operational location of 171° West longitude, and transition it into Space Network customer service operations. After acceptance of TDRS-H, Bob Jenkens, head of the TDRS Project, commended the TDRS Project team, "I would like to acknowledge the significant effort put forth by the entire team. You have done an outstanding job through this extended period of time and unforeseen set of circumstances. Congratulations on a job well done!"

This event marks the culmination of a long period of hard work by the NASA and Boeing team. In recognition of these efforts, the TDRS Project Team received a NASA Group Achievement Award on August 8, 2001. The citation on the award reads, "In recognition of your dedication, professionalism, and outstanding efforts in the development and launch of the first replenishment TDRS."

The team continues to work the final resolution of several technical issues on TDRS-I, and will then proceed with the launch and on-orbit checkout. In parallel, the TDRS-J spacecraft is being readied to undergo system level sine vibration and acoustic testing later this year. The TDRS-J launch is planned for the fall of 2002.

For more information on the TDRS Project, please contact Robert W. Jenkens via email (Robert.W.Jenkens.1@gsfc.nasa.gov) or telephone (301-286-8034).



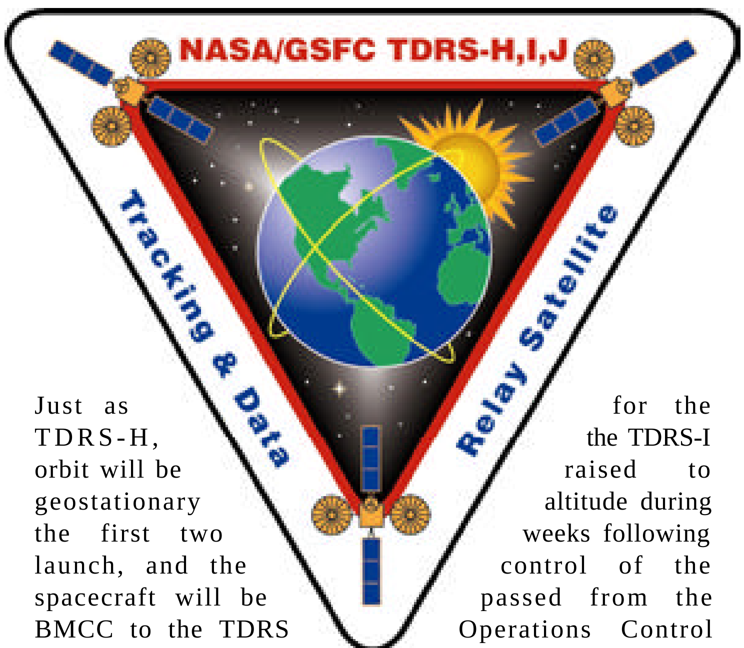
Forecast Schedule for TDRS H, I, J (as of 10/25/01)

Operational Elements Prepare for TDRS-I Launch

The TDRS Project Office has completed a series of major reviews to establish the status of preparations of the operational elements supporting the upcoming TDRS-I launch. These reviews included the Mission Design Review (MDR)/Operations Readiness Review (ORR) and the White Sands Complex (WSC) Readiness Review (WRR), both held in August 2001 at Boeing Satellite Systems (BSS) in El Segundo, CA. In addition, the JPL Network Readiness Review was conducted in September in Pasadena, CA. Key personnel from BSS, GSFC, JPL and CSOC presented information regarding their respective areas of responsibility to independent review teams.

For the MDR/ORR and the WRR, the reviews were conducted for an integrated team from the GSFC Systems Review Office, a NASA Integrated Independent Review Team composed of senior experts from outside NASA, and a senior independent review team from Boeing. The JPL Review team was comprised of senior JPL managers. The Review Teams reported in their findings that the operations elements are well prepared to support the TDRS-I mission, and ready to proceed with final pre-launch testing and training.

To support the TDRS-I mission, personnel and operational resources managed by two NASA centers (GSFC and JPL) will be integrated with Boeing's Mission Control Center (BMCC) and Flight Operations Team (FOT) to conduct the launch and transfer orbit operation. The TDRS-I mission transfer orbit design is very similar to that successfully utilized for TDRS-H in July 2000. However, there have been some personnel changes to the Flight Operations Team, modifications to the transfer orbit sequence of events based upon the TDRS-H lessons learned, procedural changes resulting from the fact that the TDRS-I launch occurs later in the year, and equipment upgrades at the primary tracking stations. The review teams focused intensely on these items during the reviews.



Just as for the TDRS-H, the TDRS-I orbit will be raised to geostationary altitude during the first two weeks following launch, and the control of the spacecraft will be passed from the BMCC to the TDRS Operations Control (TOCC) at the WSC in New Mexico. At this point in the mission, the spacecraft's attitude will be 3-axis stabilized, and both Single Access antennas will be deployed in a configuration ready to begin the payload activation and checkout phase of the mission.

At WSC, the WSC Maintenance and Operations team will support a team of BSS Flight Directors and payload test engineers in performing a two-month long payload test program to calibrate the TDRS-I antennas, and verify the function and performance of the S-, Ku-, and Ka-band communications payloads.

By Edward Lowe/GSFC Code 454

For additional information, please contact the author via email (Edward.T.Lowe.1@gsfc.nasa.gsfc) or via telephone (301-286-6664).

TDRS-I Spacecraft Completes Final Testing

TDRS-I has completed Final Integrated System Test, Flight Finalization, and Mass Property measurements at the Boeing Satellite Systems facilities in El Segundo, CA. During these processes engineers reinstalled the solar wings, performed electrical grounding checks, installed deployment flight ordnance, performed final installation of the thermal blankets, and mechanically configured the spacecraft for launch. The solar wings had been removed following spacecraft vibration to allow for deployment tests of the Space-Ground link antenna and the Forward Omni antenna. These activities were completed by the end of September.

The spacecraft Pre-Ship Review was held during the last week of August at the Boeing factory. Prior to that review, NASA and Boeing engineers began taking a second look at the deployment of the large Single Access Antennas. Motivated by data from test deployments on TDRS-I, they concluded that investigating a modification as risk mitigation against a possible hang-up was warranted. Management decided to delay the spacecraft shipment date and chartered a team to pursue possible modifications. The team has since designed a push-off spring enhancement, which has been implemented on TDRS-I and is being tested on the spacecraft this week. Engineers have successfully completed more extensive qualification testing on TDRS-J, demonstrating the effectiveness of the new mechanism. This modification is being made to TDRS-I and TDRS-J. Both Single Access Antennas successfully deployed on TDRS-H.

The Single Access Antenna reflectors on TDRS-I had been stowed (folded into their taco shape) for launch in mid-September. Once knowledge of the possible extent of the launch postponement was known, Boeing unfurled the reflectors to prevent permanent deformation caused by setting of the composite materials. Each reflector may be furled for up to 120 days before these effects begin to impact performance.

As the design modification effort nears completion, NASA and Boeing are working together with the Expendable Launch Vehicle contractor to reestablish a launch date for the spacecraft.

To learn more, contact Jeff Gramling via telephone at (301) 286-6652, or via email (Jeffrey.J.Gramling.1@gsfc.nasa.gov.

TDRS-I Launch Update

The TDRS-I spacecraft is currently scheduled for launch on an Atlas Centaur IIA launch vehicle from Space Launch Complex (SLC) 36A at the Cape Canaveral Air Station (CCAS) no earlier than December 2001. Boeing Satellite Systems (BSS) is currently performing modifications to the Single Access Antenna deployment system to provide additional clearance margin for deployment of the antennas on orbit. Testing of the hardware modifications to the TDRS-I spacecraft were in progress the week of October 22, 2001, at the BSS factory in El Segundo, CA.

Preparations for the launch are proceeding well. Lockheed Martin Astronautics (LMA) has successfully erected the TDRS-I booster on the launch pad at SLC 36A, and the launch vehicle integration verification process is underway. Kennedy Space Center (KSC) staff conducted the Ground Operations Review (GOR) at KSC on August 23, 2001, to confirm KSC's readiness to receive, process, and launch TDRS-I. LMA and the KSC Expendable Launch Vehicles (ELV) Program Office successfully conducted a Mission Unique Red Team Review on September 20-21, 2001, to review the unique aspects of the TDRS-I launch on the Atlas Centaur vehicle.

Significant upcoming events include the Mission Readiness Review at GSFC and the KSC Center Director's Launch Vehicle Launch Readiness Review at KSC to confirm the readiness of GSFC and KSC to process and launch TDRS-I.

By Mike Goeser/GSFC Code 703

For additional information, please contact the author via email (mike.goeser@gsfc.nasa.gov) or telephone (301-286-0427)

The photo on the left shows the Centaur upper stage being hoisted into position on the TDRS-I Atlas IIA booster while the photo on the right is a picture of the TDRS-I Atlas Centaur IIA launch vehicle on launch Pad 36 A at Cape Canaveral Air Force Station, Florida. *(Photographs are courtesy of Kennedy Space Center.)*

TDRS Resident Office Monitors TDRS–I and –J Activities

The excitement of an impending launch of one of our "babies" has permeated the entire TDRS Project, including the Resident Office here at Boeing Satellite Systems in El Segundo, California. Engineers have just finished testing the newly designed Single Access (SA) antenna deployment assistance devices on the TDRS I spacecraft. After Boeing declares the spacecraft "Ready," the NASA Project Office at GSFC will establish a new launch date.

Meanwhile, work is continuing on TDRS J, with integration of the high gain SA antennas, the Space Ground Link antenna and the two Omni antennas. The Multiple Access (MA) antenna array is already installed, and has been tested with the new design modifications.

The next step in Integration and Test on TDRS J is vibration and acoustic testing in the launch configuration. Following those two launch-simulating environmental tests, the various antennas will be deployed by firing the flight pyrotechnic devices and using zero gravity simulation devices. After antenna deployments, all spacecraft subsystems will be thoroughly tested, including the complex communications payload. Subsequent to this exhaustive series of tests, the spacecraft will be placed in the launch configuration (but with SA antenna reflectors unfurled) and new pyrotechnic devices installed. At that point, the spacecraft will be placed into storage. A few months before the anticipated Fall 2002 launch date, the spacecraft will be removed from storage and prepared for launch.

Following the tragic events of September 11, travel from GSFC to California has been quite limited. As a result, Resident Office personnel have taken over some general and specific functions that NASA GSFC personnel would normally accomplish. In addition, experienced personnel from The Aerospace Corporation have been asked to assist with the monitoring and reporting effort, including:

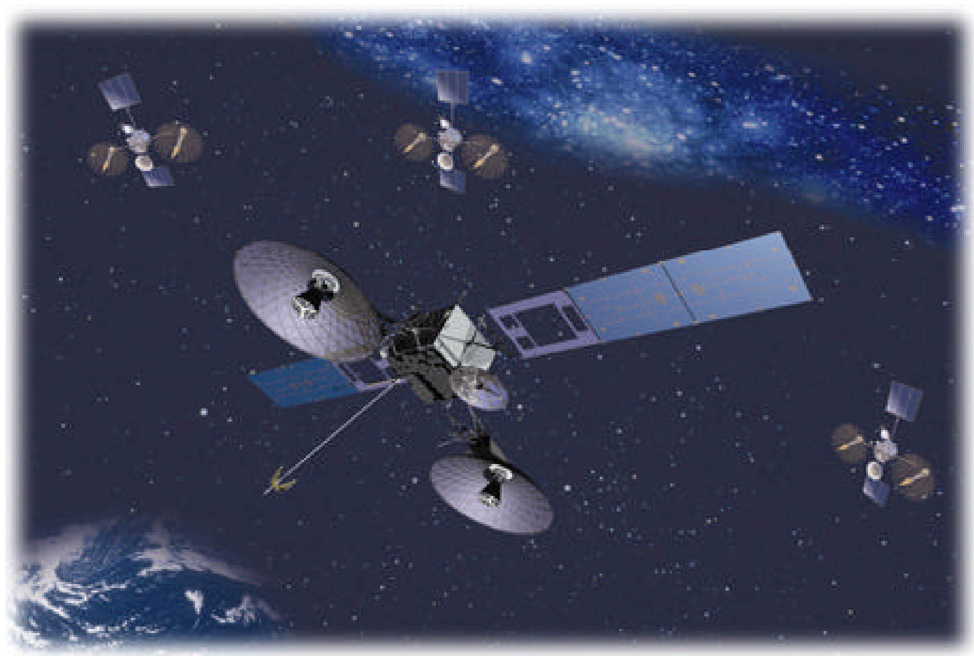
1. Data review of Payload Performance Verification Matrix items
2. Closely monitoring and reporting on detailed Integration and Test activities
3. Observing special tests, such as the newly designed SA antenna deployment assistance devices.

By Paul Nordin/TDRS Resident Office

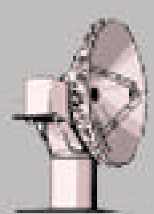
For additional information, please contact the author via email (Paul.Nordin@HSC.com) or telephone (310-364-7405).

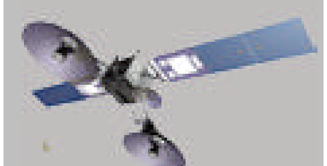
We are developing a new TDRS web site.

Stay tuned for more details in the next issue of The Integrator.



TDRS-H: Replenishing NASA's Switchboard in the Sky





The Integrator

can be accessed online at
http://msp.gsfc.nasa.gov/integrator/.

Previous issues of this publication can also be found online in *The Integrator* Archive.

If you have questions, comments, or suggestions for *The Integrator*, please contact:

Lynn Myers via
E-mail (lynn.myers@gsfc.nasa.gov)
Phone (301-286-6343) or
Fax (301-286-1724)

Edited By:
Lena Braatz (Booz|Allen|Hamilton)

Layout & Illustration By:
Sherri Tearman (Booz|Allen|Hamilton)